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INSTRUCTION MANUAL
2001L-PT/1501L-PT/751L-PT (

California INSTRUMENTS

Invertron® AC POWER EQUIPMENT

MP MASTER
MA28320

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INSTRUCTION MANUAL
2001L-PT/1501L-PT/751L-PT (EMI)

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1. INTRODUCTION

1.1 INTRODUCTION

This instruction manual contains information on the installation, operation, calibration, and maintenance of the California Instruments Model 2001L-PT/1501L-PT and 751L-PT. The 2001L-PT/1501L-PT and 751L-PT will hereafter be referred to as the AC Power Source. The difference between the 2001L-PT, 1501L-PT and 751L-PT will be detailed throughout the manual.

1.2 GENERAL DESCRIPTION

This instrument is a high efficiency power source that provides a low distortion sine wave output. The AC Power Source can supply up to 2000VA for the 2001L-PT, 1667 VA for the 1501L-PT and 835 VA for the 751L-PT. See the following table for the full output VA rating.

MODEL	OUTPUT VA	
	35°C	50°C
2001L	2000	1800
1501L	1667	1500
751L	835	750

Full power is available at the maximum output voltage on either of two voltage ranges. The standard voltage ranges are 135 and 270. Three optional voltage range pairs are available: 67.5/135, 156/312 and 200/400.

Full power is available from 45 Hz to 550Hz . The AC Power Source is illustrated in Figure 1-1.

1.3 ACCESSORY EQUIPMENT/RACK SLIDES

General Devices Model CTS-1-20-B307-2 rack slides may be attached to the sides of the power source using 10-32 X 1/2 flat head screws.

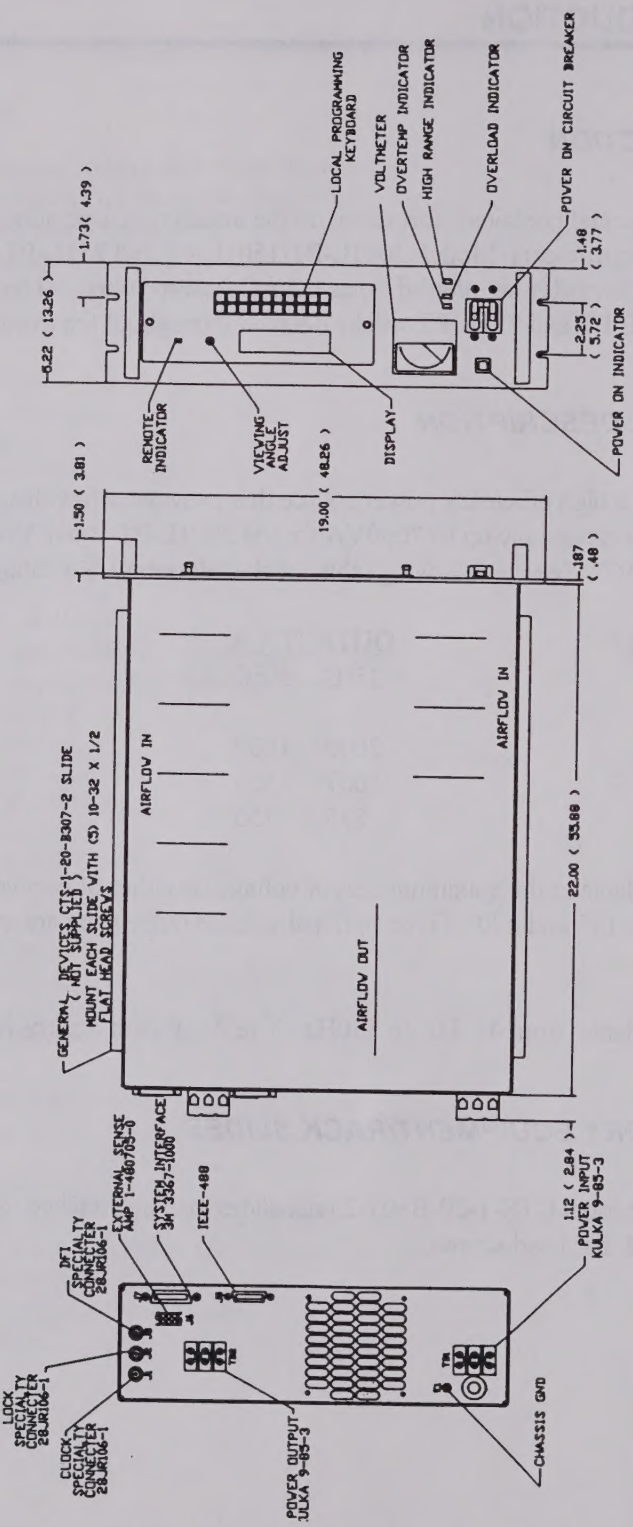


FIGURE 1-1
CALIFORNIA INSTRUMENTS 2001L

1.4 SPECIFICATIONS

Table 1-1 contains the operation specifications of the AC Power Source. All specifications are tested in accordance with standard California Instruments test procedures. The following specifications apply for operation at 100% of full scale voltage, constant line voltages and under no-load conditions unless specified otherwise.

TABLE 1-1

2001L/1501L /751L-PT SPECIFICATIONS

ELECTRICAL SPECIFICATIONS

All specification apply using external sense, 25±1°C, constant line and load condition, after 15 minute warm up unless other wise specified.

OUTPUT

	Total Power, VA		Maximum Current, Amps			
			135 volt		270 volt	
	35°C	50°C	35°C	50°C	35°C	50°C
2001L	2000	1800	14.8	13.3	7.4	6.65
1501L	1667	1500	12.34	11.12	6.17	5.56
751L	835	750	6.18	5.56	3.09	2.78

All other Voltage Ranges: Current = Power/Voltage Range

Power factor:	0 to 1.0.
Peak Repetitive Current:	2.5 times the maximum current at 50°C 2001L: 4.0 times maximum current at 50°C
Peak Non-repetitive (20 ms) Current:	2.7 times the maximum current at 50°C 2001L: 4.0 times the maximum current at 50°C
Voltage range:	135/270 volts STD 67.5/135 volts LV option 156/312 volts HV option 200/400 volts EHV option
Total Distortion	1%

Line regulation: 0.02% of full scale for ±10% of input line voltage.

Load regulation:	45Hz to 100 Hz	100Hz to 550 Hz
At 50 ° C Current	-0.5%	2%
At 35 ° C Current	-0.6%	2.2%

Voltage accuracy (at no load): ±0.7% of full scale voltage Range.
± 2 volts, 5 to 200 volts (EHV option)
± 3.5 volts, 200 to 400 volts (EHV option)

Voltage accuracy, (below 45 Hz) Add 2% of programmed value.

Frequency range: 45 Hz to 550 Hz. at full scale voltage.

Frequency accuracy: ±0.001% of programmed value.

PROTECTION

Output overload: Default to initial volts and open output relay, no recovery. Output relay is option in 751L.

Output short circuit: Default to initial volts and open output relay, no recovery. Output relay is option in 751L.

Sense Line Fault: Default to initial volts and open output relay if applicable, no recovery.

Overtemperature: Default to initial volts and open output relay if applicable, no recovery.

MEASUREMENTS

Voltage accuracy:	±1.0 Volt.
Voltage resolution:	0.1 Volt.
Current accuracy:	±0.1 Amps.
Current resolution:	0.01 Amps.
True power accuracy:	±10 Watts.
True power resolution:	1 Watt.
Apparent power resolution:	1 VA
Power factor resolution:	0.001.
Frequency accuracy:	±0.02 Hz to 99.99 Hz, ±0.2 Hz to 499.9 Hz, ±0.5 Hz to 550 Hz,
Measurement Accuracy: below 45 Hz	add 2% of reading.

TABLE 1-1

2001L/1501L /751L-PT SPECIFICATIONS(CONTINUED)

SUPPLEMENTAL SPECIFICATIONS

ELECTRICAL

Input

Line voltage: 103 - 127 VAC.
187 - 253 VAC.

Current (pf=0.6, eff=75%, volt=103, full load): 36 Amps (2001L)

Line frequency: 47 - 440 Hz.

Efficiency: 75% typical.

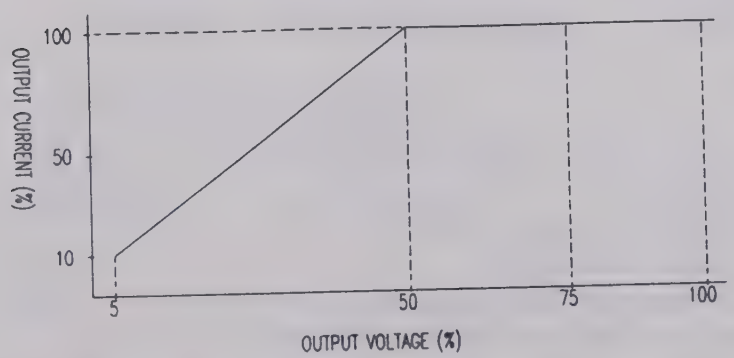
Surge current (turn-on) 185 amps at high line voltage.

Output

Output noise (20 KHz to 1 MHz at full load)
200 mv rms (typical)
160 mv rms (2001L)
Voltage temperature coefficient:
±0.05of full scale/°C.

Voltage stability (24 hours):
±0.25% of full scale under constant load, line and temp.

Full Current Range: (See graph below)

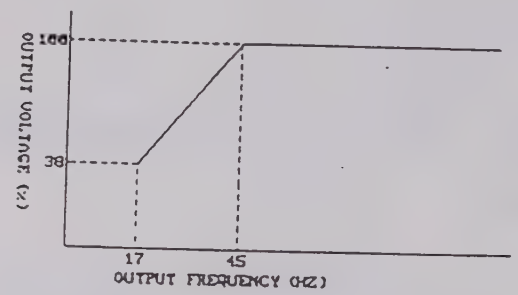


Steady state output impedance:
45 to 100 Hz= (voltage range * 0.006)/ full load current.
100 to 550 Hz= (voltage range * 0.022)/full load current.

Voltage settling Time:
(from start of voltage change to final value, full load) 0.5 millisec.

Frequency Range:

At less than Full-scale Voltage: (Refer to graph below)



Frequency temperature coefficient:
±5 ppm per degree C.

Frequency Stability:
±15 ppm per year.

Isolation: 500 Volts rms input to output.

CONTROL

Front panel controls:

- Power on/off circuit breaker with indicator.
- 20 Key Keypad.

Bus: IEEE 488.

- Subsets: SH1, AH1, T6, L3, SR1, RL2, DC1, DT1.
- Codes and formats:
  Numeric NR1, NR2, or NR3.
  Headers: HR1 or HR2.
  Message separators: SR1.
- Data transfer rate 200K bytes/ second. DMA mode.

- Language: California Instruments language that is upward compatible from other C.I. product

Functions

Voltage:

Range:	0 to voltage Range
Resolution:	0.1 Volt
Initialization:	0.0 Volts STD

Voltage Range:

Range:	135/270
Resolution:	0.1 Volt.
Initialization:	135 Volt Range.

Frequency:

Range:	45 to 550 Hz.
Resolution:	0.01 Hz from 45 to 99.99 Hz, 0.1 Hz from 100 to 550 Hz,
Initialization:	60 Hz STD.

Current Limit:

Range:

2001L 0 to 14.8 Amp on 135V range.
0 to 7.4 Amp on 270V range.

1501L 0 to 12.34 Amp on 135V range.
0 to 6.18 Amp on 270V range

751L 0 to 6.18 Amp on 135V range
0 to 3.09 Amp on 270V range.

For other Voltage Ranges:

Current Limit Range = (35° C VA)/Voltage Range

Accuracy:	-0 to +15% of programmed value
Resolution:	0.01 Amp
Initialization:	Maximum value of range

Phase Angle: (to external sync only)

Range:	0 to 999.9 degree
Resolution:	0.1 degree
Initialization:	Last setup value

Sync:

Range:	Internal/External

Initialization: Internal

Waveform: (Option only)
Range: Sine wave/square wave
Initialization: Sine wave.

Drop Period:
Range: 1 to 5 cycles
Drop Point 0 to 360 degrees

Sweep/step:
Of voltage, frequency, current up to two functions simultaneously.

Calibrations:
Of output voltage and Measurement functions

Service request:
Remote function only with option to enable and disable after errors, faults, and end of measurements.

Status:
Remote Status Byte and Status Message.
Display Status Message only.

Group Execute Trigger:
Remote function only, Trigger setups and terminate programs.

Registers and Register Linking:
16 Register will store programmable parameter with abilities to link them to each other.

FEATURES

Remote shut down:
A logic low will program the output to initial volt and open the output relay if applicable.

Output Relay(2001L and 1510L standard, 751L option):
Normally open at power up. In local control, relay will close with the first programmable function. Output Relay can be controlled remotely.

Function Sync:
400usec low logic output level when voltage and frequency is programmed.

External Sync:

A TTL logic level with a frequency of 45 Hz to 550 Hz as an input. The output will track the frequency and phase of the input.

Remote Sense:
Will compensate for 10% drop in output wiring voltage losses.

Indicators:
Power on, high voltage range, overtemperature, output overload, and 2 lines 16 character each LCD type display.

Elapse Time Indicator:
Display the accumulated Power on time.

MECHANICAL

Dimensions: 5.25 inches (13.3 cm)high,
23 inches (58.4 cm) deep,
19 inches (48.3 cm) wide

Weight: 2001L - 75 lbs (34 kg)
1501L - 75 lbs (34 kg)
751L - 70 lbs (31.7 kg)

Material: Aluminum front panel, steel chassis.

Finish: Gray 26440 per Fed Std 595.

Air intake/exhaust: Sides/rear.
Modularity: Modules interconnected with motherboard.

Connectors: Input - Kulka 9-85-3.
Output - Kulka 9-85-3.
Sense - Amp 1-480705-1.
Interface - 3M3367-1000.

Chassis slides: Zero Manufacturing CTN-1-20-E94.

ENVIRONMENTAL AND QUALITY

Operating temperature: 0 to 50°C.

Storage temperature: -40 to 85°C.

Operating altitude: 0 to 6000 feet.

OPTIONS:

Output Voltage Ranges:

High Voltage:	156/312
Low Voltage:	67.5/135
Extra High Voltage:	200/400

Master:
Must use LK Option
Slave:
Must use LK Option

Square Wave:

Rise Time:	40usec (10% to 90%).
Droop:	10%
Overshoot:	20% (resistive load)

Output Relay: 751L only.(std for 1501L 2001L)

MIL704D:
Performs all sections of MIL704D

RTCA/DO-160C (DO-160C Option)
Performs all sections of RTCA/DO-160C

SYSTEMS

None

CAUTION

Voltages up to 400 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH

On contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied.

2. INSTALLATION AND ACCEPTANCE

2.1 UNPACKING

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. DO NOT return an instrument to the factory without prior approval. Do not destroy the packing container until the unit has been inspected for damage in shipment.

2.2 POWER REQUIREMENTS

2.2.1 AC LINE VOLTAGE

The AC Power Source has been designed to operate from either of the following AC line voltage ranges:

1) 103 to 127 volts
2) 187 to 253 volts.

CAUTION: ***The AC Power Source will be damaged if it is operated at an input voltage that is outside its configured input range.***

The input voltage range is set at the factory. Section 2.3 gives the procedure to change the input voltage range.

2.2.2 LINE FREQUENCY OPERATING RANGE

The AC Power Source has been designed to operate over the line frequency range from 47 Hz to 440 Hz.

2.2.3 INPUT POWER

The input power to the AC Power Source depends upon line and load conditions and may be as high as 2650 watts. (2001L)

2.3 INPUT VOLTAGE RANGE SELECTION

WARNING: *Voltages up to 360 VDC and 270 VAC are present in certain sections of this power source. This equipment generates potentially lethal voltages.*

DEATH: *On contact may result if personnel fail to observe safety precautions. Do not touch electric circuits when power is applied. Servicing should only be performed by trained personnel.*

The input voltage range is configured by two wires and eight jumpers. See Figure 2-2 for the location of the A6 board (DC Supply) where the jumpers are located.

2.3.1 LOW INPUT VOLTAGE RANGE CONFIGURATION

Remove input power at the rear panel of the power source before attempting to change the voltage range configuration.

The low input voltage range is set by making the following connections inside the power source:

Wire W5 4005-050-005 From CB1B-LN to A6-E2.
Wire W11 4005-050-011 From DS1 to A6-E7.

Jumper A6-J1 From 2 to 5.
Jumper A6-J1 From 3 to 4.
Jumper A6-J2 From 2 to 5.
Jumper A6-J2 From 3 to 4.
Jumper A6-J3 From 2 to 5.
Jumper A6-J3 From 3 to 4.
Jumper A6-J4 From 2 to 5.
Jumper A6-J4 From 3 to 4.

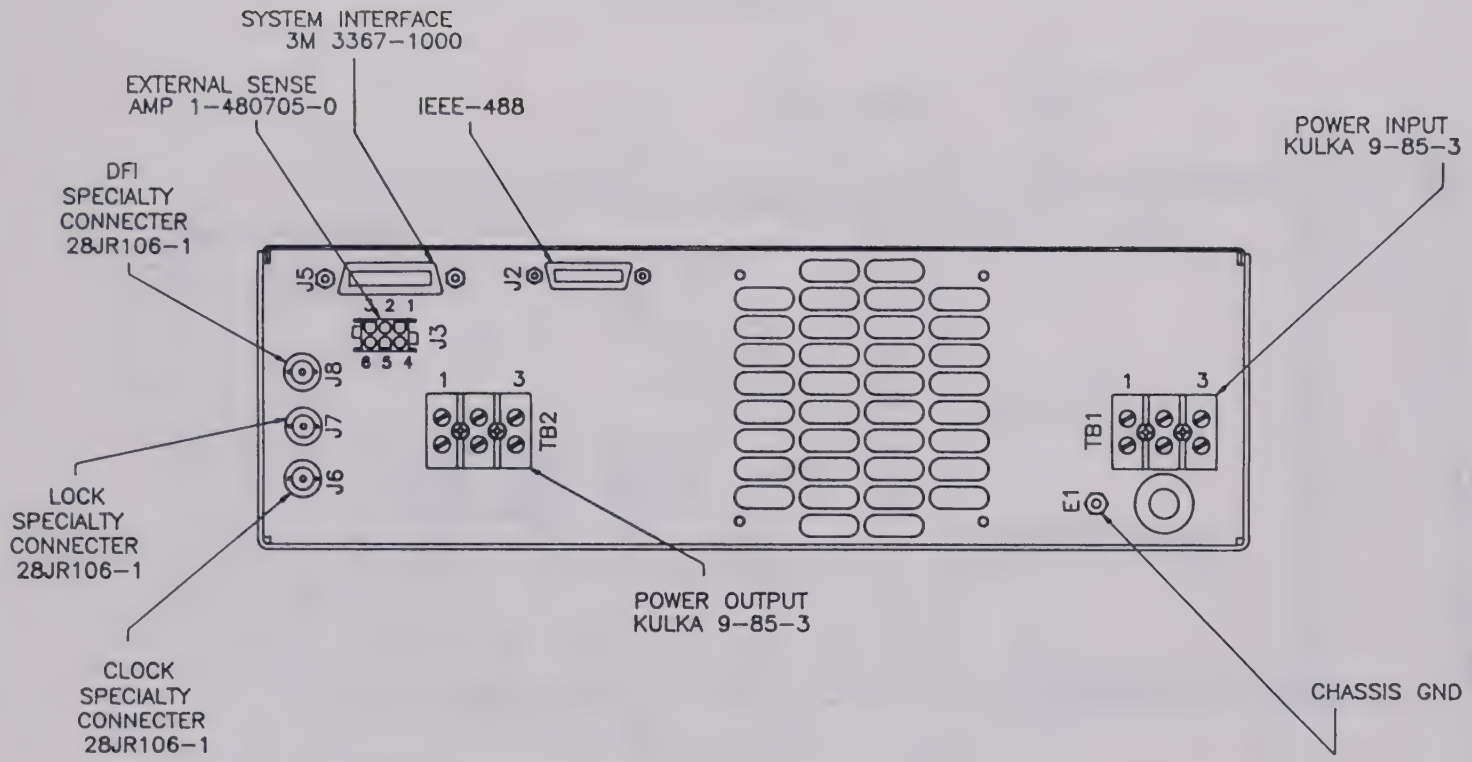
2.3.2 HIGH INPUT VOLTAGE RANGE CONFIGURATION

Remove input power at the rear panel of the power source before attempting to change the voltage range configuration.

The high input voltage range is set by making the following connections inside the power source:

Wire W5 4005-050-005 From CB1B-LN to CR1-AC.
Wire W11 4005-050-011 From DS1 to A6-E4.

Jumper A6-J1	From 1 to 6.
Jumper A6-J1	From 2 to 3.
Jumper A6-J2	From 1 to 6.
Jumper A6-J2	From 2 to 3.
Jumper A6-J3	From 1 to 6.
Jumper A6-J3	From 2 to 3.
Jumper A6-J4	From 1 to 6.
Jumper A6-J4	From 2 to 3.



TB1

PIN	FUNCTION
1	HI INPUT
2	LO INPUT
3	GND

J3

PIN	FUNCTION
1	ø C SENSE
2	ø B SENSE
3	ø NEUT SENSE
4	ø A SENSE

TB2

PIN	FUNCTION
1	HI OUTPUT
2	LO OUTPUT
3	GND

FIGURE 2-1
751L/1501L/2001L REAR PANEL CONNECTIONS

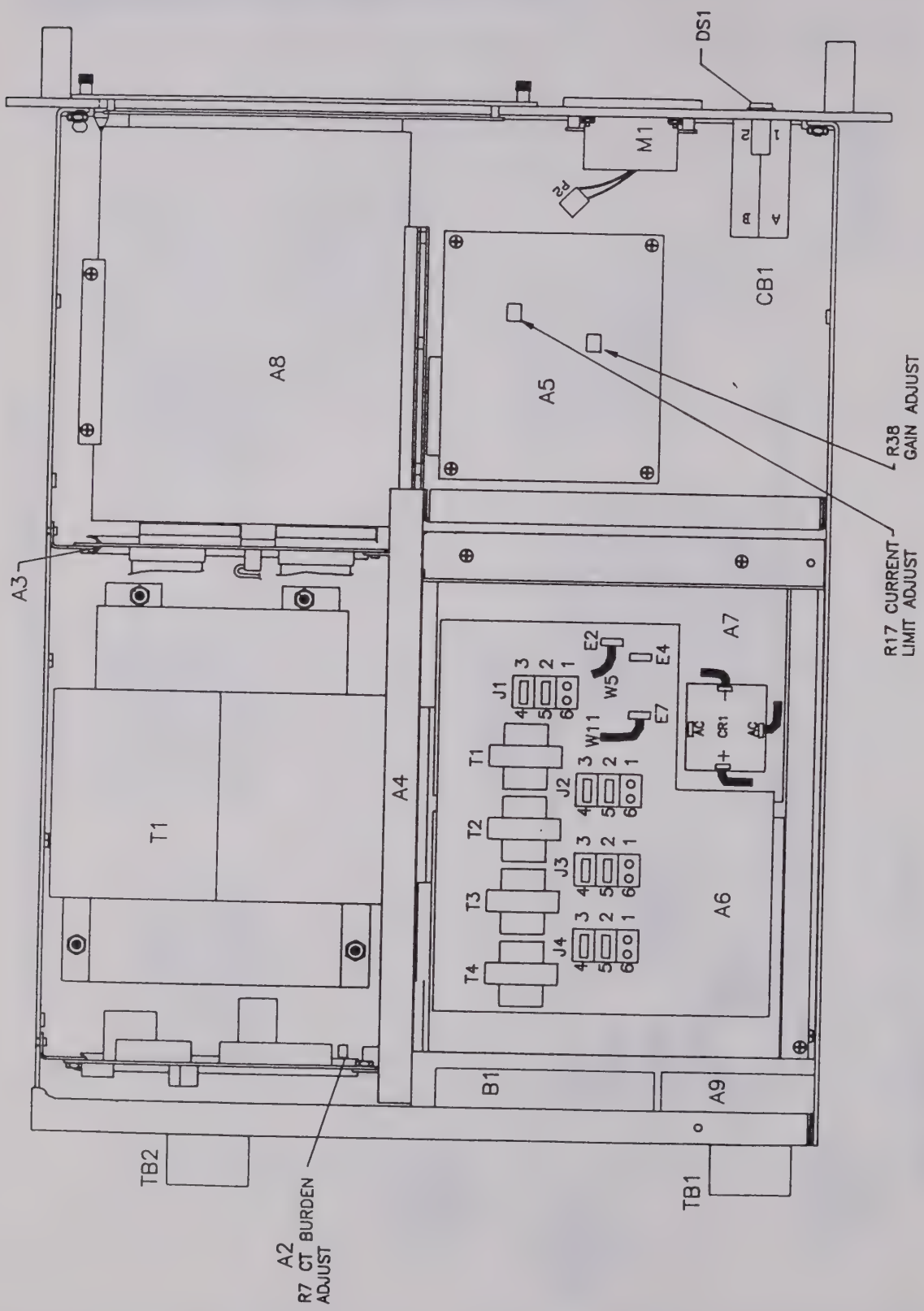


FIGURE 2-2
INTERNAL ADJUSTMENTS AND JUMPER LOCATIONS
FOR INPUT LINE VOLTAGE VOLTAGE 104 TO 126 VOLTS
(SHOWN WITH AMPLIFIER & HEATSINK SUPPORT REMOVED)

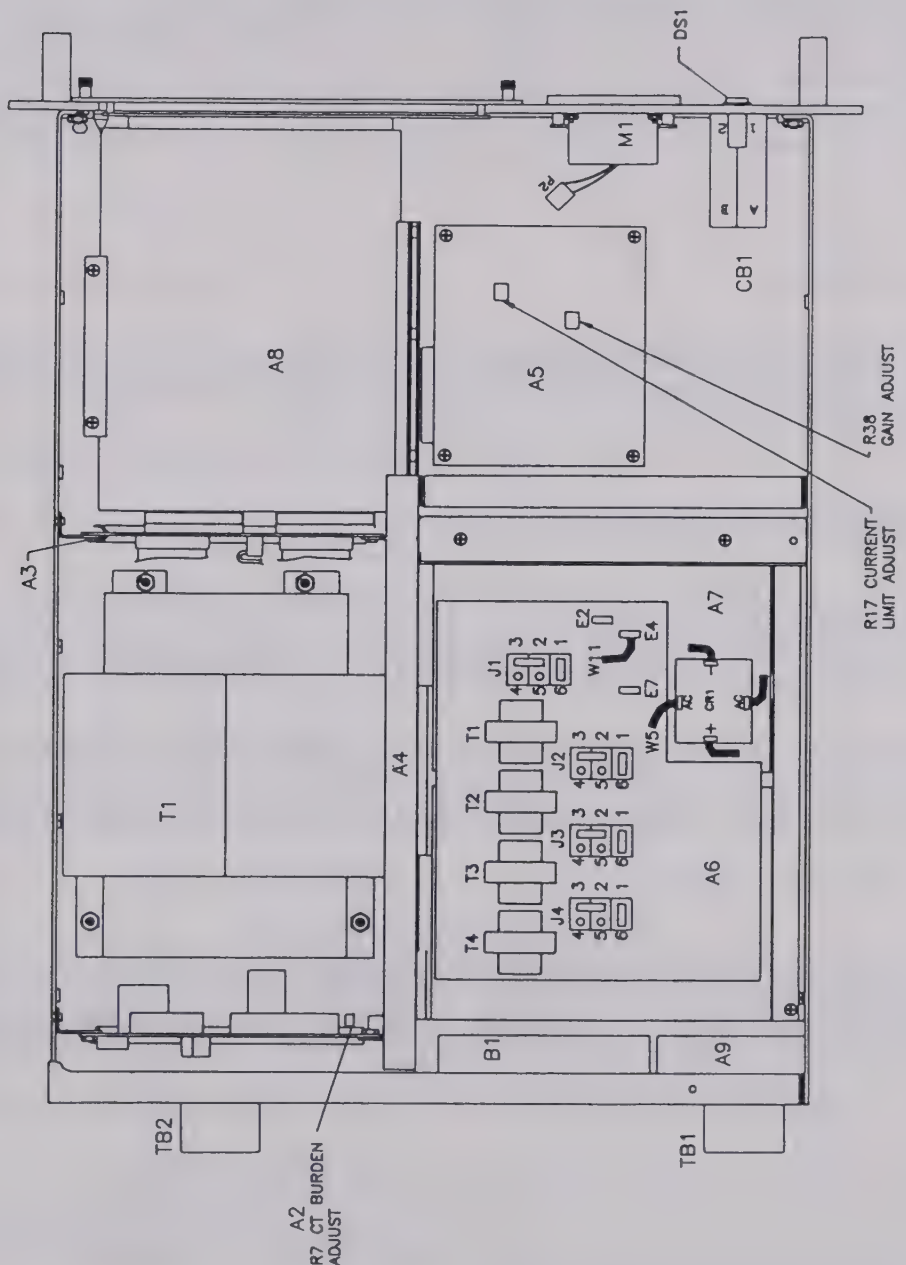


FIGURE 2-2
INTERNAL ADJUSTMENTS AND JUMPER LOCATIONS
FOR INPUT LINE VOLTAGE 187 TO 253 VOLTS
(SHOWN WITH AMPLIFIER & HEATSINK SUPPORT REMOVED)

2.4 MECHANICAL INSTALLATION

The power source has been designed for rack mounting in a standard 19 inch rack. The unit should be supported from the sides with optional rack slides. See Accessory Equipment/Rack Slides in paragraph 1.3. The cooling fan at the rear of the unit must be free of any obstructions which would interfere with the flow of air. A 2.5 inch clearance should be maintained between the rear of the unit and the rear panel of the mounting cabinet. Also, the air intake holes on the sides of the power source must not be obstructed. See Figure 1-1.

2.5 INPUT WIRING

The AC Power Source must be operated from a three-wire single phase service. The mains source must have a current rating greater than or equal to the AC Power System circuit breaker, 35 amps. Connect AC mains to TB1. Refer to Figure 2-1 for the input power connections.

2.6 OUTPUT CONNECTIONS

The output terminal block, TB2, is located at the rear of the power source. All load connections must be made at TB2. The remote sense inputs allow the power source output voltages to be monitored directly at the load and must be connected. The remote sense wires are connected at J6 on the rear panel.

The output power cables must be large enough to prevent a voltage difference greater than 10% of the programmed value between TB2 and the voltage between Remote Sense HI and LO input. Table 2-1 shows the maximum length of the output wires. The table assumes the Remote Sense input is connected at the load.

Table 2-1 : Minimum Wiring Size

MAXIMUM OUTPUT CURRENT IN AMPS	WIRE GAUGE (AWG)	MAXIMUM LENGTH (IN FEET) WIRE BETWEEN OUTPUT AND LOAD
14.8	14	46
14.8	12	73
14.8	10	117

The Remote Sense inputs must be connected or an AMP FAULT error message will be shown on the display and reported through the remote interface.

2.7 OUTPUT VOLTAGE RANGES

The standard voltage ranges for this AC Power Source are 135 and 270. Selecting of the 270 volt range causes the front panel "HIGH RANGE" lamp to illuminate. The range may be changed from either the front panel keypad or through the GPIB input.

2.8 FUNCTION TEST

Refer to Figure 2-3 for the test setup.

Perform the following test sequence.

1) Apply the AC line power and turn on the front panel circuit breaker. No loads should be connected to the output terminal block.

2) Verify that the POWER ON lamp is lit.

3) With the front panel keypad program the 270 range with the following key sequences:

   4 ENT — To select the Range screen (RNG)

   270 PRG ENT — To program the 270 range

4) Verify the HIGH RANGE lamp is lit.

5) Program the output to 270 volts with the following key sequences:

   Depress the MON key 1 time to select the Amplitude screen (AMP).

   270 PRG ENT To program the voltage to 270 volts

6) Verify that the front panel voltmeter indicates approximately 270 volts.

7) Program the AC Power Source to the 135 volt range with the following keystrokes:

   4 ENT 135 PRG ENT

8) Program the output to 135 volts:

   5 ENT 135 PRG ENT

9) Observe the output with the oscilloscope or distortion analyzer. The output should be a clean sine wave having less than 1.0% distortion.

10) Apply a full load (9.1 Ω, 2000W FOR 2001L, 10.9 Ω, 1667 watts for 1501L and 21.8 Ω, 835 watts for the 751L). Verify that the output voltage remains within 0.067 volts of the no-load voltage. The waveforms shall still appear clean on the oscilloscope and have less than 1% distortion.

11) Program the Current Limit to 5.0 amps:

    8 ENT

    5 PRG ENT

12) The display should show the error message 'AMP FAULT'. The output will default to its initial voltage value with the output relay open if the option is installed.

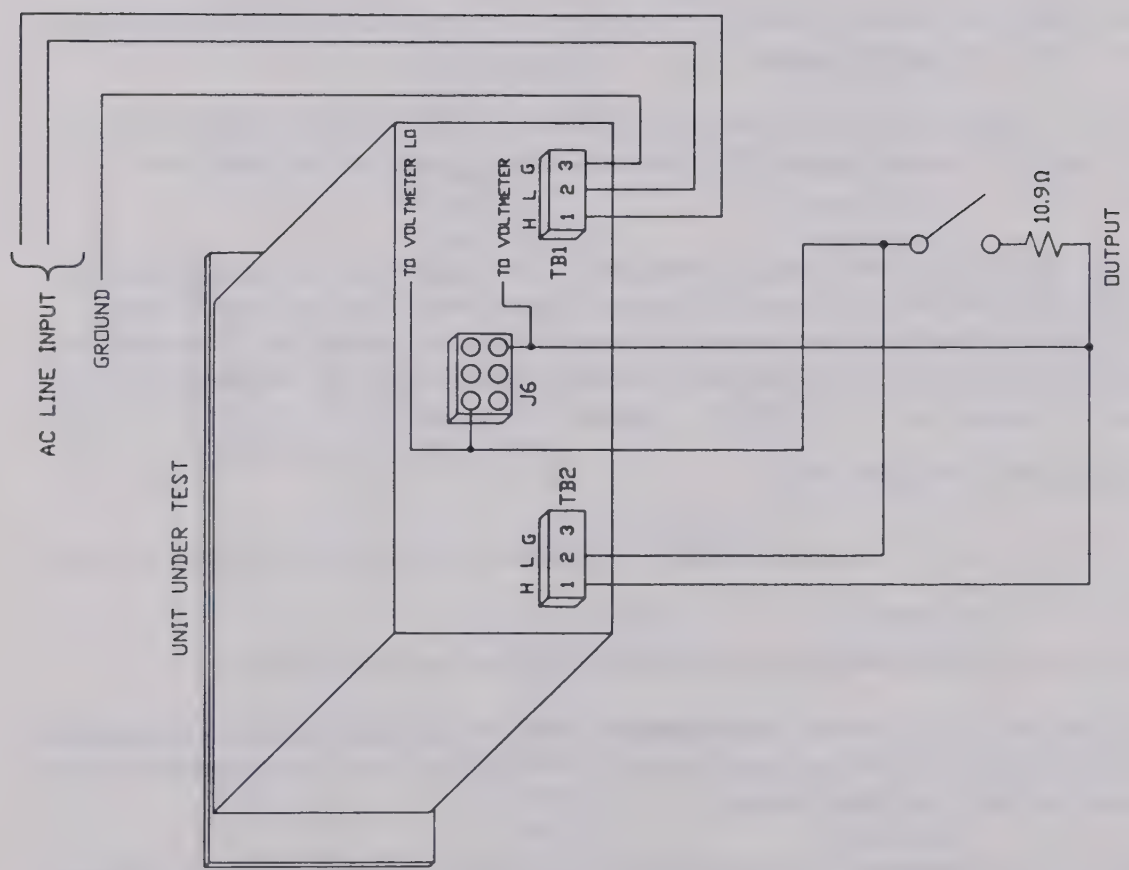


FIGURE 2-3
TEST SETUP

3. OPERATION

3.1 GENERAL

The AC Power Source may be programmed from the front panel or through the IEEE-488 remote interface. The rear panel of the AC Power Source holds the power input and output terminals remote sense connector, system interface connector, IEEE-488 interface connector and the chassis ground stud.

3.2 FRONT PANEL CONTROLS

All front panel controls are shown in Figure 3-1. A voltmeter is located at the left side of the front panel.. The voltmeter shows the output volt status.

A circuit breaker is on the left side of the front panel. The circuit breaker is used to switch power to the unit. When the circuit breaker is switched ON, the amber indicator lamp above the circuit breaker illuminates.

The front panel has a subpanel with a keypad, remote lamp, LCD display and a viewing angle adjustment. The 20-key keypad allows the power source to be manually programmed at the front panel. The knob labeled VIEW ANGLE many be turned to adjust the contrast of the front panel display. The remote lamp illuminates when the AC Power Source has been addressed through the IEEE-488 interface (GPIB).

3.3 FRONT PANEL INDICATORS

A lamp is located just above the input circuit breaker. It illuminates when power is applied and the circuit breaker is on.

An analog voltmeter, that indicates from 0 to 300 volts, shows the actual output voltage.

An OVERTEMP lamp illuminates when the temperature of the power amplifier heatsink has surpassed a maximum set level. When the fault is detected, the output is disabled and must be reprogrammed after the overtemperature condition has been eliminated.

An OVERLOAD lamp illuminates when the output current exceeds the programmed current limit value. The output will default to the initial value and the output relay will open shortly after the condition occurs (Output Relay is an option in the 751L).

A HIGH RANGE lamp illuminates when the AC Power Source is programmed to the high voltage range.

An LCD digital display shows the numeric value of all programmed output parameters. It also shows all error messages and measured values.
A REMOTE lamp illuminates when the AC Power Source has been addressed from the IEEE-488 interface.

3.4 REAR PANEL CONNECTIONS

TB1 is the terminal block for the three input wire. Terminals 1 and 2 connect to the High and Low input. Terminal 3 is the chassis connection which should be connected to the input main ground.

TB2 is the power output terminal block. Refer to Table 3-1 for identification of the TB1 and TB2 terminals.

Table 3-1

TB 1	DESCRIPTION	TB2	DESCRIPTION
1	Input HI	1	Output HI
2	Input LO	2	Output LO
3	Chassis Ground	3	Chassis Ground

J6 is the remote sense input connector. The remote sense input must be connected to the respective AC Power Source output. If the inputs are not connected, an AMP FAULT error message will be generated. Table 3-2 identifies the pins of connector J6.

Table 3-2

J6	DESCRIPTION	CONNECT TO:
1	Do not connect	
2	Do not connect	
3	Sense LO	Output LO
4	Sense HI	Output HI
5	No Connection	- - - - -
6	No Connection	- - - - -

J5 is the IEEE-488 (GPIB) connector.

J7 is the System Interface connector. Table 3-3 identifies the pins of the System Interface connector.

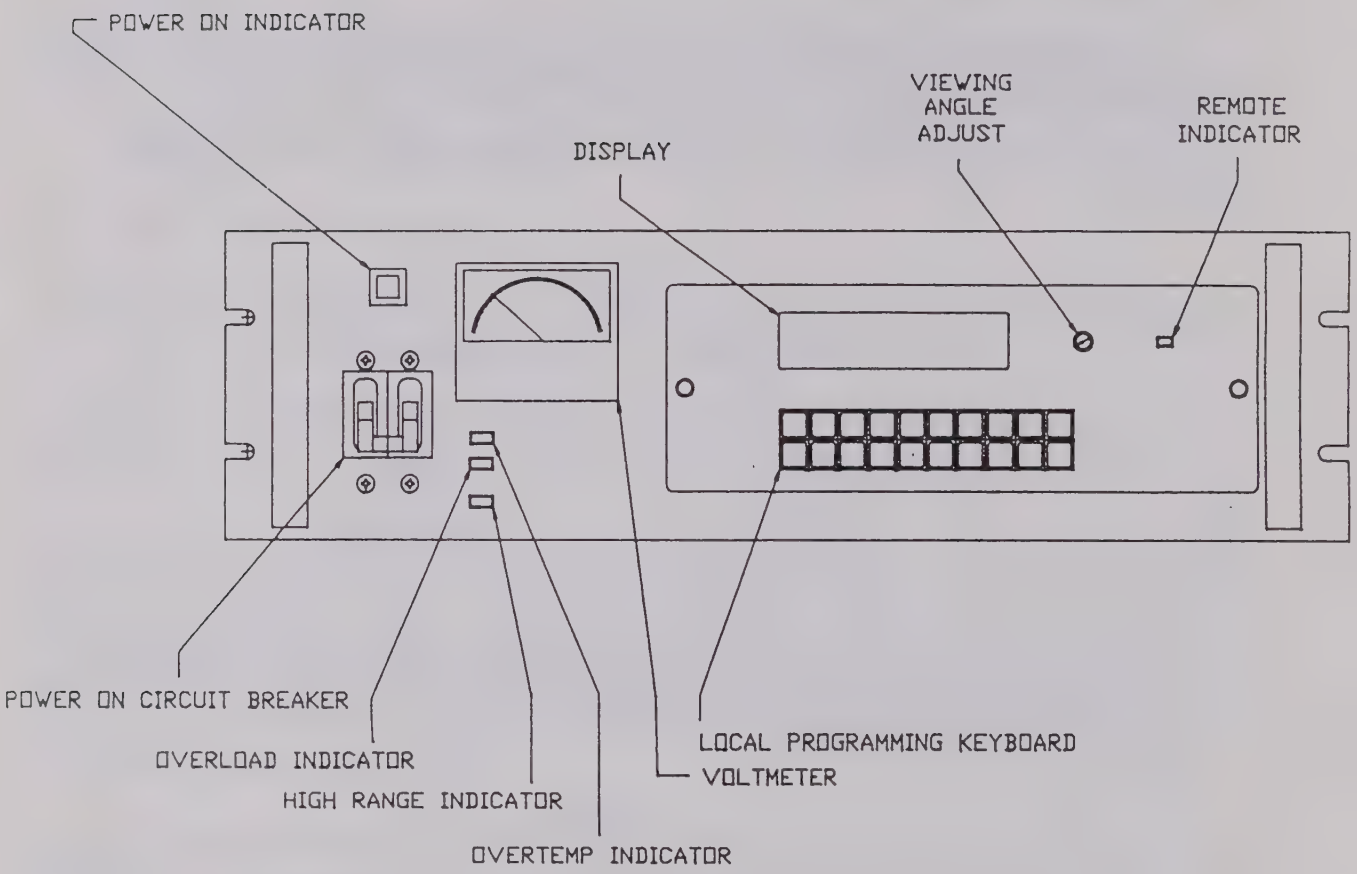


FIGURE 3-1
FRONT PANEL CONTROLS AND INDICATORS

Table 3-3: System Interface Connector J7 1

J7	Description
1	Analog Common
3	Analog Common
5	CT Common, Current Transformer Common
7	Analog Common
9	RPV, Not used
10	OVP TMP , Overtemperature indication
11	CNF, Output relay (1501L)(751L if option installed)
13	FLT A, Phase A current limit fault
14	F STB LO, Function Sync output LO
15	EX SYNC LO, External Sync input LO
16	No connection
17	No connection
18	No connection
20	MR A, Phase A amplifier input signal
22	CS A, Phase A current sum
24	OS A, Oscillator Phase A output
26	CL A, Phase A DC current limit
27	D COM, Digital Common
28	RNG HI, High Voltage range
31	F STB HI. Function Sync output HI
32	EX SYNC HI, External Sync input HI
36	REMOTE SHUTDOWN

J7-1 ANALOG COMMON: This is the common for all analog signals on the connector.

J7-3 ANALOG COMMON: See J7-1.

J7-5 CT COMMON:

J7-7 ANALOG COMMON: See J7-1.

J7-9 RPV: Not used.

J7-10 $\overline{\text{OVR TMP}}$: A logic low output to indicate an overtemperature condition.

J7-11 $\overline{\text{CNF}}$: Output relay control indication. This is an output logic line that indicates the state of the output relay. A logic low indicates the output relay is open. The output relay is available as an option in the 751L. It is a standard feature in the 1501L.

J7-13 FLT A: Make no connections.

J7-14 F STB LO: a Function Sync signal. This is the emitter lead of an optically isolated NPN transistor. The internal power controller turns this transistor on to indicate a change of programmed values.

J5-15 EX SYNC LO: External Sync Low signal. This is the ground return for the TTL external sync input. It connects to the cathode of an LED at the input of an optocoupler. Refer to J7-31.

J7-16 No connection.

J7-17 No connection.

J7-18 No connection.

J7-20 MR A: This is the input signal to the phase A amplifier from the internal oscillator drive signal. Do not make any connection to this pin except for troubleshooting.

J7-22 CS A: Current sum for the phase A output. Make no connection to this pin.

J7-24 OS A: This is the output from the internal phase A oscillator. Use this pin as an input if an oscillator is not installed. 5.0 VRMS on this pin will generate a full-scale output voltage.

J7-26 CL A: A DC level from the oscillator used to set the current limit for phase A.

J7-27 D COM: Digital common.

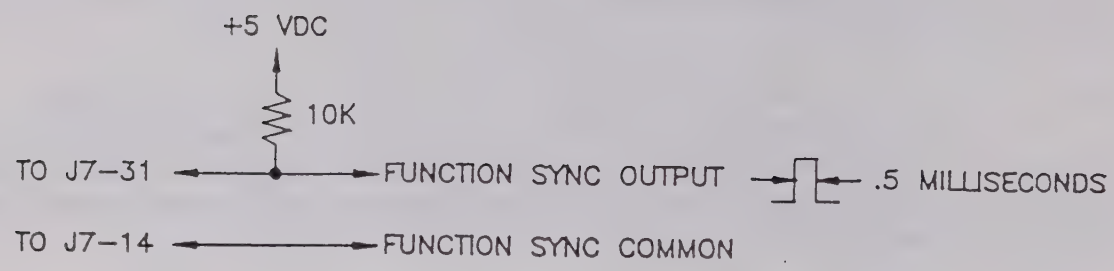
J7-28 $\overline{\text{RNG HI}}$: A logic output from the internal oscillator to control the Range relays. A logic low on this pin indicates the high voltage range. If the power system is used without an oscillator, this pin is a logic input.

J7-31 F STB HI: Function Sync High signal. This is the collector lead of an optically isolated NPN transistor. The internal power controller turns this transistor on to indicate a change of programmed values. This output will sink more than 2 milliamps to a TTL low logic output level (<.4 volts). The output is an open, collector optocoupler output. A pullup resistor to a + VDC must be connected to J7, pin 31. J7, pin 14, is the common output. Refer to Figure 3-2.

J5-32 EX SYNC HI: External Sync High signal. This is an input that can be used to synchronize the outputs of the AC Power Source. This input requires a logic high level of at least +4.5 VDC at 1.5 ma. The input should have a duty cycle 50 +10%. J7-15 is the common input. The External Sync input is optically isolated. It must also be enabled from the SNC screen.

J7-36 REMOTE SHUTDOWN: This is a logic input that can be used to remove the programmed output voltage. A logic low on this pin will cause the output voltages to be programmed to 0.0 volts and the output relays to open. A logic high will cause the programmed output voltage to be restored at the output terminals. A contact closure between this pin and J7-27 (DCOM) will simulate a logic low state.

Figure 3-2: Function Sync Connections



3.5 FRONT PANEL PROGRAMMING

3.5.1 KEYPAD

The front panel keypad is enabled whenever the REMOTE light is not lit. The AC Power Source may be manually programmed by using the keypad while observing the front panel LCD display.

Figure 3-3 shows the front panel keypad. Table 3-4 lists the key and a brief description. While viewing any Output Parameter screen (Ref. Table 3-5), the screens may be viewed in increasing order by depressing the MON key and in decreasing order by de-pressing the PRG key. While viewing the Measurement Screens, the MON and PRG keys work in a similar fashion. For example, if the AMP parameter screen is displayed, the FRQ screen may be dis-played by pressing the MON key one time. The display will be switched back to the AMP screen by pressing the PRG key.

Figure 3-3: Keypad

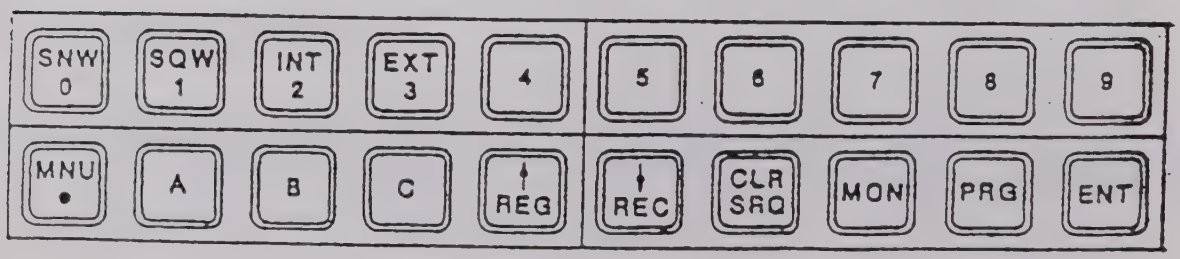


Figure 3-4: Keypad Key Description 1

KEY	DESCRIPTION
SNW/0	Inputs the value "0" for all output parameters or to select screen "0" when followed by the ENT key. Also used to select the sine wave waveform.
SQW/1	Inputs the value "1" for all output parameters or to select screen "1" when followed by the ENT key. Also used to select the square wave waveform.
INT/2	Inputs the value "2" for all output parameters or to select screen "2" when followed by the ENT key. Also used to select the Internal Synchronize or Internal Clock modes of operation.
EXT/3	Inputs the value "3" for all output parameters or to select screen "3" when followed by the ENT key. Also used to select the External Synchronize or External Clock modes of operation.
4 through. 9	Inputs the indicated numeric value for all output parameters or to select the corresponding screen when followed by the ENT KEY
MNU/.	Selects the Menu screens that show all display screens and the corresponding numeric value. The decimal point function of this key is enabled after any numeric key is depressed.
A	Used to direct any parameter change to phase A. Also used to update any quantity in the display identified as A=.
B	Used to direct any parameter change to phase B. Also used to update any quantity in the display identified as B=.
C	Used to direct any parameter change to phase C. Also used to update any quantity in the display identified as C=.
↑/REG	Used to increment the value in any output parameter screen or calibration screen. Also used to load the program register into any register identified by the preceding numeric value.
↓/REC	Used to decrement the value in any output parameter screen or calibration screen. Also used to recall the program register identified by the preceding numeric value.

TABLE 3-4 (CONTINUED)
KEYPAD KEY DESCRIPTION

KEY	DESCRIPTION
CLR/SRQ	Used to clear the numerical inputs for the display screen.
MON	Used to display programmed output parameter values. Used repeatedly, it will cause the display screens of increasing numeric numbers to be displayed.
PRG	Used to program setup values in the Program Register. Used repeatedly, it will cause the display screens of decreasing numeric numbers to be displayed.
ENT	Used to transfer the contents of the program register to the actual output parameters.

3.5.2 DISPLAY SCREENS

A display of data on the front panel LCD display is called a screen. There are four types of screens: menu, output parameter, measurement and configuration screens.

Menu screens display the screen abbreviation with its equivalent number. The numeric value for each item in a menu screen is the code that may be used to select the screen. Tables 3-5 through 3-8 show the numeric values for all screens. Without the aid of the tables the MNU key may be used. The menu screens will dis-play only the programmable features that are enabled and their associated screen number.

Table 3-5 shows all of the available Output Parameter screens. While viewing any of the screens, the associated output parameter may be changed from the keyboard.

Table 3-6 shows all of the Measurement screens. When accessing some Measurement screens up to three seconds may be required to display the screen.

Table 3-7 shows all of the screens for calibrating the output and measurement functions. A special code is required to access these screens. Refer to Section 4, Calibration.

Table 3-8 shows all of the Configuration screens. The only value that is user programmable is the IEEE-488 (GPIB) Listen Address.

Table 3-5: Output Parameter Screen 1

SCREEN NO.	NAME	EXT.	ARGUMENT	ACTION TAKEN
	The following are for changing the output:			
1	SNC		INT, EXT	Selects the output to be synchronized to an external input.
2	DRP		1 - 5	Sets the amplitude number of the drop cycle. PHZA value will define the start point of the drop cycle.
3	WVF		SNW, SQW	Sets the output waveform.
4	RNG		Range limit	Selects the output voltage range. Range limit values of 135 and 270 are standard.
5	AMP		0-RNG limit	Sets the output voltage amplitude.
6	FRQ		45-550	Sets the output frequency.
8	CRL		0 to maximum current	Sets the output current limit.
9	RMP A	DLY	0.001-9999	Sets the Delay between ramp steps in seconds. Four decade resolution from 0.001 to 9999 seconds.
		STP		Sets the step size of ramp parameter.
		VAL		Sets the final value of the parameter ramped.
	RMP B	STP		Same as RMPA
		VAL		Same as RMPA

NOTE: RMPA and RMPB screens are not accessible until AMP, FRQ, CRL or PHZ are programmed (PRG) but not yet entered (ENT).

Table 3-6: Measurement Screens 1

SCREEN NO.	NAME	EXT.	ARGUMENT	ACTION TAKEN
The following are for measured values.				
11	ELT	H, M, S	Hrs,Min,Sec	Reports the total accumulated run time up to 99,999 hours.
21	VLT		0-400.0	Measures the TRMS output voltage.
22	CUR		0.00-20.00	Measures the TRMS output current in Amps.
23	PWR		0-2000 watts	Measures the True output power.
24	PWF		0-1.000	Measures the power factor of the load.
25	APW		0-2000 VA	Measures the apparent output power.
26	FQM		40-550	Measures the output frequency in hertz.
27	PZM		0-359.9	Measures the phase angle of the output voltage relative to an external input.

Table 3-7: Calibration Screen 1

SCREEN NO.	NAME	EXT.	ARGUMENT	ACTION TAKEN
13	CAL VLT		Actual output voltage	Calibrates the measured voltage to be same as argument.
14	CAL CUR		Actual output current	Calibrates the measured current to be same as (amps) argument.
15	CAL PWR		Actual output power	Calibrates the measured power to be same as argument. The argument is in watts.
20	POF		0-±359.9	Calibrates the programmed output phase angle relative to external reference if used.

Table 3-8: Configuration Screen 1

SCREEN NO.	NAME	EXT.	ARGUMENT	ACTION TAKEN
16	CFG	A(LSN)	0-30	Sets the IEEE-488 (GPIB) Listen Address.
		B(CFG)	*188 (1501L) *156 (751L)	Defines the features enabled for Power Source compatibility.
		C(PHZ)	0	Defines the phase C initial value for power system configuration.
17	ALM	A(RNG)	0	[1]Code that defines the default voltage range.
		B(LLM)	*135	Defines the upper limit of the lower voltage range.
		C(HLM)	*270	Defines the upper limit of the higher voltage range.
18	FLM	A(FRQ)	60	Defines the default frequency.
		B(LLM)	*45	Defines the low frequency limit.
		C(HLM)	*550	Defines the high frequency limit.
19	CLM	A(RNG)	*Max Current	Defines the maximum current limit value.
		B(PRS)	*0	Defines the decimal point location for measured power.
		C(CRS)	*2	Defines the decimal point location for measured current.
29	INI	A(AMP)	0-5	Defines the initial voltage output.
		C(CRL)	0-Max Current	Defines the initial current limit.

***NOT USER PROGRAMMABLE.** THE VALUES SHOWN ARE FOR A 1500 VA POWER SOURCE. THE VALUES WILL BE DIFFERENT FOR OTHER SOURCES DEPENDING ON REQUIREMENTS.*

[1] A code of 0 defines the Low Voltage Range. A code of 8 defines the High Voltage Range.

3.5.3 TO PROGRAM OUTPUT VOLTAGE AMPLITUDE (AMP=5)

***NOTE:** The remote sense lines must be connected to J6 on the rear panel of the AC Power Source. If they are not properly connected an AMP FAULT message will result when the output voltage amplitude is programmed above the default value. Refer to Figure 2-2.*

Select the Amplitude (AMP) screen by entering keystrokes:

5 ENT

The display now shows the AMP parameter screen:

AMP MON A = 5.0 (or the initial value)

Program the output to 115.5 volts with the keystrokes:

115.5 PRG ENT

Program output to 130.0 volts.

130 PRG ENT

Slowly increase the output amplitude:

↑ (Hold until desired value is obtained.)

The output frequency can be programmed below 45 Hz down to 17 Hz. For operation between these frequencies, the output voltage Amplitude is limited to values described by the following formula:

AMP = VOLTAGE RANGE * FREQUENCY/45

3.5.4 TO PROGRAM FREQUENCY (FRQ=6)

Select the Frequency (FRQ) screen by entering the keystrokes:

6 ENT

Program the output to 60.23 hertz:

60.23 PRG ENT

To incrementally increase the output frequency to a desired value:

↑ (Hold until desired frequency is reached.)

3.5.5 TO PROGRAM THE OUTPUT PHASE ANGLE (PHZ=7)

Output phase can be programmed relative to external sync. To program External Sync refer to paragraph 3.5.10. To program output phase to 90 degrees relative to External Sync perform the following sequence:

1. Select the phase (PHZ) screen by entering:

   7 ENT

2. Program phase to 90 degree relative to External Sync by entering:
   90 PRG ENT

3.5.6 TO PROGRAM CURRENT LIMIT (CRL=8)

1. Select the Current Limit screen by entering:

   8 ENT

2. Program the current limit to 5 amps:

   5 PRG ENT

3.5.7 TO PROGRAM VOLTAGE RANGE (RNG=4)

The RNG screen has two purposes; to select a range defined by the range pair selected in the Amplitude Limit (ALM) screen and to select an upper voltage limit less than that specified by the ALM screen, LLM or HLM values. If the range pair 135/270 has been selected in the ALM screen with LLM=135 and HLM=270, the 135 range of the power source will be programmed by the RNG screen for any value of 135 or less. The value programmed will then be the maximum value allowed to be programmed in the Amplitude (AMP) screen.

To select the 270 range and set a program amplitude limit of 250 volts, perform the key sequence below:

4 ENT 250 PRG ENT

3.5.8 TO PROGRAM RAMP OR STEP FUNCTIONS (RMP=9)

The Ramp (RMP) function allows any programmable parameter (AMP, FRQ, PHZ, CAL or CRL) to be Stepped (STP) with a Delay (DLY) for each step to a final value (VAL). There are three types of programs that may be specified by the RMP screen; a ramp and two types of step programs.

The step function will program the output parameter value speci- fied by a previous screen for the time specified for the DLY value in seconds. The parameter will then return to a final value specified by the VAL value. The ramp function will step the output parameter value specified by a previous screen with the STP value, the DLY time per step and the final VAL setup in the RMP screen. The ramp will increment if the VAL value is larger than the parameter value. It will decrement if it is less than the parameter value.

NOTE: The DLY, STP or VAL parameters must be specified (A, B or C key depressed) before the number value for the parameter is entered.

When ramping frequency, an error message will result with an attempt to step the frequency with greater resolution than that possible by the initial or final values.

The step program may also be used to generate a dropout to zero volts at any point on the waveform. This type of program is selected by setting the AMP value to zero before setting the DLY and VAL parameters. The point on the waveform at which the dropout occurs is specified by the value in the (PHZ) screen.

The following key sequence will program 130V for 2.5 seconds and then return to a final value of 115V.

1. Select the AMP screen and enable 130 volts to be programmed:

   5 ENT 130 PRG (*)

2. Select the RMP screen, program a DLY of 2.5, a final VAL of 115 volts and run the program:

   9 ENT A 2.5 PRG C 115 PRG ENT

The next example will illustrate a ramp program. The following sequence will ramp the frequency from 60 hertz to 400 hertz in .1 hertz steps with a delay (DLY) for each step of .003 seconds. The total time for this ramp will be = [(VAL-FRQ)/STP]DLY or 10.2 seconds.

1. Select the FRQ screen and set the starting frequency of 60 Hz:

   6 ENT 60 PRG

2. Select the RMP screen, set a DLY of .003, set the STP of .1, set the final VAL of 400 and run the program:

   9 ENT A 0.003 PRG B 0.1 PRG C 400 PRG ENT

The following program will illustrate a dropout to zero volts. The program will drop the amplitude to zero volt at 90 degrees for .002 seconds and return to 115 volts.

1. Select the AMP screen and program phase A to 115 volts:

   5 ENT 115 PRG ENT

2. Select the PHZ screen and program to 90:

   7 ENT 90 PRG

3. Select the AMP screen and program the dropout voltage to zero volt:

   5 ENT 0 PRG

4. Select the RMP screen. Set a delay of .002 seconds and a return value of 115 volts:

   9 ENT A 0.002 PRG C 115 PRG

5. Execute the program by depressing the ENT key.

Two output parameters may be ramped simultaneously. The parame- ter programmed just prior to entering the RMP A screen will be the independent parameter and will be identified in that screen. The parameter loaded prior to the independent parameter will be the dependent parameter.

The following example will ramp frequency from 360 to 440 Hz at a rate of .2 Hz per .2 second, while each .2 Hz step causes the amplitude to go from 10 volts to 210 volts in .5 volt steps.

1. Select the AMP screen (dependent parameter) and program the start to 10 volts:

   5 ENT 10 PRG

2. Select the FRQ screen (independent parameter) and pro- gram the start frequency of 360 Hz:

   6 ENT 360 PRG

3. Select the RMPA screen and program the independent ramp parameters of STP = .2, and DLY = .2 and VAL = 440:

9 ENT A 0.2 PRG B 0.2 PRG C 440 PRG

4. Select the RMPB screen and program the dependent (AMP) ramp parameters of STP = .5:

10 ENT B 0.5 PRG

5. Start the program by pressing the ENT key.

The final value of the dependent parameter, AMP, will be determined by the number of steps of the independent parameter and the STP value, .5V specified in RMP B.

FINAL VALUE = INITIAL VALUE + (RMP B STP) (NO. STEPS)
NO. STEPS = (DEP. PAR.) (FINAL VALUE - INITIAL VALUE)/STEP SIZE

In this example:

NO. STEPS = (440 - 360)/.2 = 400

FINAL AMP VALUE = 10 + .5 X 400 = 210 Volts

If the final value exceeds the RNG value, an error message will be generated.

NOTE:Any ramp may be terminated at any time by depressing the ENT key.

3.5.9 TO PROGRAM THE OUTPUT WAVEFORM (WVF=3)

The waveform selection is an option for the AC Power Source. If the screen cannot be selected the option is not enabled.

The WVF screen displays the type of waveform selected, sine wave (SNW) or square wave (SQW), for each of the three outputs. To program a square wave, depress the SQW or any odd number key followed by the PRG key and ENT key.

To program the output to square wave:

SQW PRG ENT

To select the sine wave waveform depress the SNW or any even number key followed by the key sequence described above.

3.5.10 TO PROGRAM EXTERNAL SYNCHRONIZATION (SNC=1)

The SNC screen displays whether the external or internal SNC mode of operation has been selected. While viewing this screen to select the external SNC mode depress the EXT key followed by the PRG and ENT key:

Example: EXT PRG ENT

While operating in the EXT SNC mode, the FRQ screen will display the frequency of the External Sync signal. The signal must be between 45 Hz and 550 Hz.

NOTE: ***When viewing the SNC, CLK or WVF screens the MON or PRG keys must be used to sequence to another screen. The MNU key can also be used to return to the menu then followed by any screen selection.***

To return to the internal SNC mode of operation, depress the INT key or any even numeric key followed by the PRG and ENT key while viewing the SNC screen.

Example: INT PRG ENT

If the External Sync signal is not between 45 Hz and 5000 Hz, the message will be 'EXT SYNC ERROR'.

In the EXT SNC mode the value on the PHZ screen represents the angle of the output leading the External Sync input. If the zero degree point of the power source does not match the zero degree point of the External Sync input, the POF screen may be used for calibration. Select the POF screen and enter a value for calibration.

3.5.11 TO PROGRAM THE DROP PERIODS (DRP=29)

Select the phase (PHZ) screen by entering keystrokes: 7 ENT. The display will show the PHZ parameter screen:

PHZ MON A = 0.0

To drop the output waveform starting at 90 degrees, enter the keystrokes: 90 PRG ENT.

Select the DROP (DRP=29) screen by entering the keystrokes:

2 ENT

The display will show the DRP parameter screen

DRP MON A = 0

To drop the output waveform for 3 cycles, enter the keystrokes:

3 PRG ENT

3.3.12 TO PROGRAM TOTAL HARMONIC DISTORTION (THD=0)

The Total Harmonic Distortion screen is used to program the distortion for the output. The program range is form 0 to 20 % with 1% program resolution.

The following example will program the output voltage to 115 volts with a 10 % distoriton for 1 second.

Select the THD screen with the key sequence: 0 ENT.

Enable 10% distortion with key sequence: 10 PRG.

Select the AMP screen and enable the output to be set to 115.0 volts with the key sequence:

5 ENT 115 PRG

Select the RMP A screen and specify the output distortion and voltage time of 1 second and final value of 115.0 volts with the key sequence:

9 ENT A 1 PRG C 115 PRG

Recall a register where the undistorted waveform will be specified. Register 1 will be used in the example. Stor the operationiin register 0 with th key sequence:

1 REC 0 REG ENT

Enable the waveform to be undistorted and remain at 115 volts for 10 seconds before dropping to 0.0 volts with the key sequence:

0 ENT 0 PRG 5 ENT 115 PRG 9 ENT A 10 PRG C 0 PRG 0 REC 1 REG ENT

At this point the program may be performed by the key sequence:

0 REC ENT

3.5.13 TO PROGRAM REGISTERS AND RAMPS

The AC Power Source has 16 registers that can be used to store setups. All of the data stored in the registers will be retained during power-down. Register operation may be chained to another register by adding the REC and register number to any setup sequence. The REC and REG keys are used for register operations. Any of the previous examples may be stored in a register by adding the extra step of entering the register number followed by depressing the PRG key. This extra step must be entered before the last ENT keystroke.

The following program will program 135 volts and 60 hertz on the output for 10 seconds before reducing the output to 115 volts and store the test in register 0.

1. Select the FRQ screen and program 60 hertz:

   6 ENT 60 PRG

2. Select the AMP screen and program 60 hertz:

   5 ENT 135 PRG

3. Select the RMP screen and program DLY = 10 and VAL = 115
   9 ENT A 10 PRG C 115 PRG

4. Store the program in register 0:

   0 REG ENT

To recall and perform the register operation, simply enter the register number followed by depressing the REC and ENT keys.

3.5.14 REGISTER LINKING

Any number of registers may be linked together by using the REC key prior to loading the register operation.

The following program will ramp the voltage from 115 volts and 60 hertz to 135 volts with .1 volts per 10 millisecond steps, remain at 135 volts for 10 seconds, return to 115 volts at the same rate but at 62 Hz. Store the program in Registers 1 and 2.

1. Select the FRQ screen and program 60 Hz:

   6 ENT 60 PRG

2. Select the AMP screen and program 115 volts:

   5 ENT 115 PRG

3. Select the RMP screen and program DLY = 0.01, STP = 0.1 and VAL = 135:

   9 ENT A 0.01 PRG B 0.1 PRG C 135 PRG

4. Link this program to Register 2:

   2 REC

5. Store this program in Register 1:

   1 REG ENT

The second portion of the program will be stored in Register 2.

6. Select the FRQ screen and program 62 Hz:

   6 ENT 62 PRG

7. Select the AMP screen and program 135 volts:

   5 ENT 135 PRG

8. Select the RMP screen and program DLY = 0.01, STP = 0.1 and VAL = 115:

9. Store this program in Register 2:

   2 REG ENT

To initiate the program:

1 REC ENT

3.5.15 TO PROGRAM SIMULTANEOUS RAMPS

Two outputs may be simultaneously ramped or stepped by enabling two parameter screens. The screen first selected will be the dependent parameter. The last parameter screen selected before entering the ramp (RMP) screen is the independent parameter. The independent parameter is used to specify the number of steps in a ramp. Since the dependent parameter has as many steps as the independent parameter, the step (STP) size must be calculated so the dependent parameter will not exceed its maximum value. The following example will specify frequency as the independent parameter and phase as the dependent parameter. Refer to para- graph 3.5.8 for more information.

The following example will ramp frequency from 360 to 440 Hz at a rate of .2 Hz per .2 second, while each .2 Hz step causes the amplitude to go from 10 volts to 210 volts in .5 volt steps.

1. Select the AMP screen and specify the starting voltage of 10 volts:

   5 ENT 10 PRG

2. Select the FRQ screen and specify the starting frequency of 360 Hz.

   6 ENT 360 PRG

3. Select the RMP A screen and specify the ramp parameters of the independent parameter, FRQ, of DLY = .2 seconds, STP = .2 Hz and VAL = 440 Hz:

   9 ENT A 0.2 PRG B 0.2 PRG C 440 PRG

4. Select the RMP B screen and specify the ramp parameter of the dependent parameter, AMP, of STP = .5 volts:

   10 ENT B 0.5 PRG

5. At this point the program may be executed by depressing the ENT key or stored in a register.

3.5.16 TO PROGRAM INITIALIZATION PARAMETER

Several screens will control the initialization parameter of the power source. To access any of the following screens, the following procedures must be completed.

1. Press the menu key until you reach the first menu screen:

   CFG = 00 *SNC = 01

DRP = 02 WVF = 03

2. Enter the numeric value of 959 followed by the ENT key.

3. Press the menu key until you reach menu screen five. This screen should appear as follows:

CFG = 16 ALM = 17
FLM = 18 CLM = 19

* These are options and may not appear on the screen if options are not available.

3.5.16.1 TO PROGRAM THE INITIAL VOLTAGE RANGE

First perform paragraph 3.5.16

1. Enter the value 17 followed by the ENT key

2. Press the A value. If this value is less than 8, the unit will initialize at the low voltage range.

3. Add 8 to the value shown and enter the new value followed by the PRG key and ENT key. The unit will initialize at the high voltage range.

4. If the value is greater than 7, subtract 8 from the value and enter the new value followed by the PRG key and ENT key. This will initialize the unit to the low voltage range. Note: any other values entered will generate a syntax error.

3.5.16.2 TO PROGRAM FREQUENCY INITIAL VALUE

First perform paragraph 3.5.16

1. Enter the value 18 followed by the ENT key.

2. Select the A key. Enter the desired initial frequency value. This value must be within the frequency range of the power source or a range error will be generated.

3.5.16.3 TO PROGRAM AMPLITUDE INITIAL VALUE

First perform paragraph 3.5.16

1. Enter the value 29 followed by the ENT key.

2. Select the A key. Enter the desired initial voltage value between 0 and 5 volts followed by the PRG and ENT key. A value less than 5 volts may cause a fault condition when the output is programmed to a low value above 5 volts.

3.5.16.4 TO PROGRAM CURRENT LIMIT INITIAL VALUE

First perform paragraph 3.5.16

1. Enter the value 29 followed by the ENT key.

2. Select the C key. Enter the desired initial current limit value. This value cannot be greater than the maximum output current of the power source.

3.5.17 ERROR MESSAGES

Table 3-9 shows all of the possible error messages displayed on the front panel display. The cause of the error message is also shown.

Table 3-9: F.P. Display Error Messages

ERROR MESSAGE	CAUSE
AMP FAULT	Incorrect sense line connection. Overload on indicated output.
TEMP FAULT	Amplifier overtemperature
CPU MEMORY FAULT	CPU failed self-test
DMA OVERFLOW	Remote message greater than 256 bytes.
EXT SYNC ERROR	No external sync input at System Interface connector. Signal is not between Low Frequency Limit and High Frequency Limit.
BUS LOCAL ERROR	Remote message sent while AC Power Source is in local.
SYNTAX ERROR	Incorrect syntax received from IEEE-488 Remote Interface
AMP RANGE ERROR	Attempt to program AMP value greater than RNG value.
FRQ RANGE ERROR	Attempt to program FRQ less than Low Frequency Limit or greater than High Frequency Limit.
CRL RANGE ERROR	Attempt to program CRL greater than 11.11.
RNG RANGE ERROR	Attempt to program RNG greater than 270.0 or other optional high voltage range.
RMPA RANGE ERROR	Attempt to program STP, DLY or VAL greater than the maximum.
DIV ERROR	Consult factory.

OVERFLOW ERROR Consult factory.

3.5.18 TO MEASURE THE OUTPUT

Seven measurement screens display the output voltage, current, power, apparent power, power factor phase and frequency.

While viewing any measurement screen, except ELT, any other measurement screen may be displayed by repeatedly depressing either the MON or PRG key. The screen may also be displayed by entering its equivalent screen number followed by depressing the ENT key. Refer to Table 3-6 for all measurement screen numbers.

3.5.19 TO MEASURE THE OUTPUT VOLTAGE (VLT=21)

The voltage screen displays the actual TRMS output voltage with 0.1 volt resolution. This voltage is the voltage at the Remote Sense connector of the AC Power Source. To access the voltage screen, depress the keys:

21 ENT

3.5.20 TO MEASURE THE OUTPUT CURRENT (CUR=22)

The current screen displays the actual TRMS load current. The resolution is 0.01 amp for the AC Power Source.

3.5.21 TO MEASURE THE OUTPUT POWER (PWR=23)

The power screen displays the actual true power delivered to the load. The resolution is 1 watt.

3.5.22 TO MEASURE THE OUTPUT POWER FACTOR (PWF=24)

This screen displays the power factor from 0 to 1.000 with 0.001 resolution. The PWF screen will read unity for loads less than 10 digits of apparent power on the Apparent Power (APW) screen. When this screen is displayed after another screen, it takes approximately two seconds to update the screen.

3.5.23 TO MEASURE THE OUTPUT APPARENT POWER (APW=25)

This screen is accessed by its screen number, 25. It displays VOLT-AMPERES with a resolution of 1 VA.

3.5.24 TO MEASURE THE OUTPUT FREQUENCY (FQM=26)

This screen is accessed by its screen number, 26. It displays the output frequency with a resolution of 0.01 Hz, 0.1 Hz or 1 Hz up to 99.99 Hz, 999.9 Hz or 5000 Hz, respectively.

3.5.25 TO MEASURE THE OUTPUT PHASE ANGLE (PZM=27)

This screen is accessed by its screen number, 27. It displays phase A relative to an external synchronizing input. The resolu-tion is 0.1 degree.

3.5.26 ELAPSED TIME (ELT =11)

This screen displays the total run time accumulated on the AC Power Source up to 99,999 hours.

H = Hours M = Minutes S = Seconds

3.6 REMOTE CONTROL

Remote programming through the IEEE-488 Interface (GPIB) consists of sending the unit address and the proper ASCII alphanumeric characters to identify the parameter and the numerical value or other argument. The description of the abbreviations for GPIB messages used in this section are listed in Table 3-10. These abbreviations must not be confused with the device dependent abbreviations used to describe the AC Power Source operating parameters (ex. FRQ=Frequency, etc.).

3.6.1 UNIT ADDRESS

This is the A value (LSN) set in the CFG screen. The Unit Ad-dress 0 through 30 corresponds to the HEX value 20 through 3E. Refer to Table 3-11 for the equivalent HEX, Binary, ASCII and Decimal equivalents. The Unit Address is set at the factory to 1 but may be changed by selecting the CFG Configuration screen and setting a new value.

To select the CFG screen repeatedly depress the MNU key until menu screen #1 is displayed as illustrated below:

TDH = 00 SNC = 01
DRP= 02 *WVF = 03

Enter the key sequence: 959 ENT

Repeatedly depress the MNU key until the menu screen #5 is displayed as illustrated below:

CFG = 16 ALM = 17
FLM = 18 CLM = 19

Enter the key sequence: 16 ENT

The CFG screen will now be displayed. Depress the A key to display the present Unit Address. It may be changed to any value from 0 to 30 and will be stored in non-volatile memory. The new unit address will not be updated until power is shut off and reapplied to the power system.

The following key sequence will change the unit address to 16:

16 PRG ENT

NOTE (*): ***These screens will only be shown if the Square Wave and External Clock options are installed.***

Table 3-10: Commonly used GPIB Abbreviations

ABBREVIATION	DEFINITION
ATN	Attention. A logic line on the GPIB asserted only by the controller to indicate the data on the bus represents a bus message.
CR	An ASCII carriage return.
DCL	Device Clear. A universal bus message to initialize all instruments to their power-on states..
END	End. A message conveyed when a talker uses the EOI line with the last data byte of a data string.
EOI	End or Identify. A logic line on the GPIB asserted by a talker to indicate the last byte of a data string.
EOS	End of String. A delimiter message that consists of a data byte(s) to indicate the end of a data string.
GET	Group Execute Trigger. A GPIB message to trigger an addressed instrument.
GTL	Go To Local. A GPIB message to put an addressed instrument in the local control mode.
IFC	Interface Clear. A logic line on the GPIB asserted by the controller to clear all interfaces (ex., default to unlisten and untalk).
LF	An ASCII line feed.
LLO	Local Lockout. A GPIB message, when asserted, will inhibit the instrument from going to local if the CLR/LOC key is pressed.
REN	Remote Enable. A logic line on the GPIB asserted by the controller. REN enables an instrument to go to local when addressed.
SDC	Selected Device Clear. A GPIB message to initialize an addressed instrument to it Power-on state.

Table 3-11: Unit Address Group

LISTEN ADDRESS	HEX	BINARY A5 A4 A3 A2 A1	DECIMAL	ASCII
0	20	001 0 0 0 0 0	32	SP
1	21	001 0 0 0 0 1	33	!
2	22	001 0 0 0 1 0	34	"
3	23	001 0 0 0 1 1	35	#
4	24	001 0 0 1 0 0	36	$
5	25	001 0 0 1 0 1	37	%
6	26	001 0 0 1 1 0	38	&
7	27	001 0 0 1 1 1	39	'
8	28	001 0 1 0 0 0	40	(
9	29	001 0 1 0 0 1	41	)
10	2A	001 0 1 0 1 0	42	*
11	2B	001 0 1 0 1 1	43	+
12	2C	001 0 1 1 0 0	44	'
13	2D	001 0 1 1 0 1	45	-
14	2E	001 0 1 1 1 0	46	.
15	2F	001 0 1 1 1 1	47	/
16	30	001 1 0 0 0 0	48	0
17	31	001 1 0 0 0 1	49	1
18	32	001 1 0 0 1 0	50	2
19	33	001 1 0 0 1 1	51	3
20	34	001 1 0 1 0 0	52	4
21	35	001 1 0 1 0 1	53	5
22	36	001 1 0 1 1 0	54	6
23	37	001 1 0 1 1 1	55	7
24	38	001 1 1 0 0 0	56	8
25	39	001 1 1 0 0 1	57	9
26	3A	001 1 1 0 1 0	58	:
27	3B	001 1 1 0 1 1	59	;
28	3C	001 1 1 1 0 0	60	<
29	3D	001 1 1 1 0 1	61	=
30	3E	001 1 1 1 1 0	62	>
UNL	3F	001 1 1 1 1 1	63	?

3.6.2 MESSAGE FORMAT

The message sent to the AC Power Source must have the following format for each parameter:

HHHDXXX----------E+NND

where

H = Three letter mnemonic for each message header (except MODE).
D = Optional header extension (A, B or C) to specify output (ref. Table 3-5 through 3-8)
X = Alpha or numeric argument or # for message header argument.
E = Optional ASCII E for exponent identification
± = Exponent sign
N = Exponent value 0 to +63
D = Message string delimiter, (CR) (LF) or (LF)

More than one message header with its corresponding argument may be sent in one setup string with a common delimiter.

3.6.3 NUMERIC DATA FIELD

Parameter values may be sent as an unsigned value with a decimal point or a decimal point with an exponent. The phase value may be sent as a signed value.

The Decimal Point for numeric data values may be either sent or inferred. The two following ASCII strings will represent 115 volts.

AMP115
AMP115.0

There may be any number of digits following the decimal point, not to exceed the 256 byte DMA buffer, but only the Least Significant Digit (LSD) of resolution will be recognized. The LSD for amplitude is tenths of volts. The LSD for frequency is either hundredths or tenths for up to 99.99 Hz or 5000 Hz respectively.

Any parameter's numeric value may be of a mixed form with a decimal point and exponent. The exponent may be a numeric, with or without leading zeros, up to a value of +63. The following ASCII strings will represent 15 volts:

AMP1.15E2
AMP1.15E+2
AMP1.15E+02
AMP1150E-1

A positive exponent value is represented by either an ASCII "+" or an unsigned value.

3.6.4 PROGRAM HEADERS

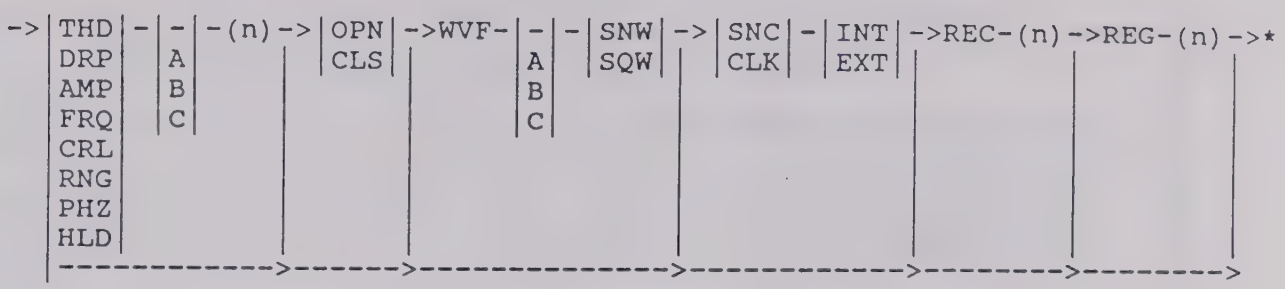
A Program Header is a mnemonic of a series of ASCII characters used to select a function or identify the data it precedes. The header is an abbreviation of the program function it identifies. The header may be followed by a header extension to separately program each segment of the header to different values. See Table 3-12 for the definition of the Program Headers and their related arguments.

Any header that is sent without an argument will cause the front display to show the corresponding screen. Refer the Figure 3-4 for a summary of all possible command sequences.

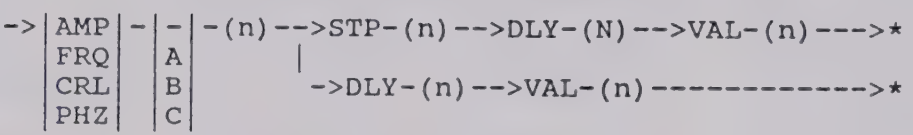
Figure 3-4: Remote Command Sequences

IEEE-488 PROGRAM SYNTAX

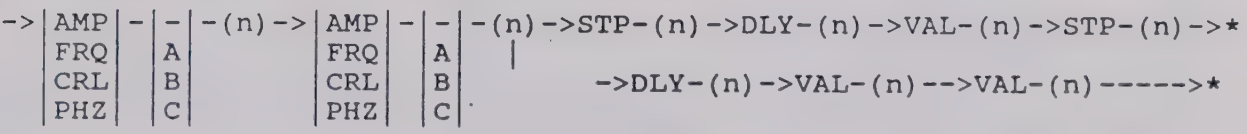
TO PROGRAM OUTPUT PARAMETERS:



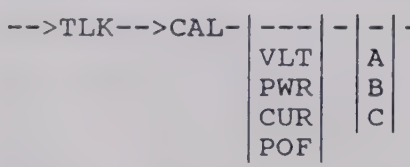
TO RAMP OR STEP ONE OUTPUT PARAMETER:



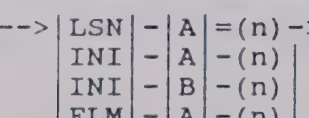
TO RAMP OR STEP TWO OUTPUT PARAMETERS:



TO REQUEST TALKING OF CALIBRATION COEFFICIENTS:



TO SET UP INITIALIZATION VALUE:



TO SPECIFY THE SERVICE REQUEST INTERRUPT:

```
-->SRQ-(n)--->*
```

TO CALIBRATE OUTPUT:

```
-->CAL-|---|-|-|-(n)-->DLY-(n)-->STP-(n)-->VAL-(n)--->*
       |AMP| |A|       |
             |B|       |
             |C|       |------------------------------->*
```

TO CALIBRATE MEASUREMENT:

```
-->CAL->|VLT|-|-|-(n)---->*
        |CUR| |A|
        |PWR| |B|
            |C|
```

TO REQUEST TALKING A PROGRAMMED PARAMETER OR MEASURED VALUE:

```
-->TLK-->|AMP|-|-|----->*
         |FRQ| |A|
         |CRL| |B|
         |RNG| |C|
         |PHZ|
         |SNC|
         |THD|
         |DRP|
         |MNU|
         |ELT|
         |VLT|
         |CUR|
         |PWR|
         |APW|
         |PWF|
         |ALM|
         |FLM|
         |CFG|
         |POF|
         |HLD|
         |INI|
```

TO RECALL A REGISTER:

```
-->REC-(n)--->*
```

* Represents either an IEEE-488 END or EOS message. The EOS message may be either an ASCII Carriage Return(CR), Line Feed(LF) or just LF.

n Represents a numeric value.

Table 3-12: Program Headers 1

HEADER	EXTENSION	ARGUMENT	DEFINITION
AMP		# or numeric from 0.0 to RNG value.	Amplitude in volts
CAL or CAL AMP		# or numeric data from 0.0 to 255	Calibration Coefficient for output voltage
CAL VLT		Actual voltage	Calibrated measured voltage at remote sense point.
CAL CUR		Actual current	Calibrate measured current
CAL PWR		Actual power	Calibrate measured power.
CLK		INT, EXT	Clock source
CRL		0 to maximum current	Current limit in amps
DLY		0.000 to 9999 seconds	Delay in seconds used as a ramp parameter
DRP		0 to 5	Number of Drop cycles
FRQ		45.00 to 5000	Frequency in hertz.
PHZ		0 to 999.9	Output phase angle relative to external sync.
PRG		0 through 15	Load register with preceding data
REC		0 through 15	Recall register or specify link register if it is preceded by program argument followed by PRG and register number
REG		0 through 15	Register load
RNG		0.0 to 270 or other optional range value	Amplitude range and limit value in volts
SNC		INT,EXT	Synchronize
INI	A	0 to 5.0	Voltage initial value.
	C	0 to maximum	Current limit initial value current
ALM	A	0 to 15	Select initial voltage range. See programming for details.
FLM	A	0 to freq. range	Set initial frequency.
SRQ		0, 1 or2	Service Request disable, enable or at completion of program and measurements.
STP		From parameter minimum to maximum value	Define step size in ramp.

HEADER	EXTENSION	ARGUMENT	DEFINITION
TLK		Any header	Set up to talk argument value or measured value when addressed to talk.
TRG			Execute (Trigger) setup parameters on GPIB "GET" message.
VAL		From parameter minimum to maxi mum value	Final ramp or step value in volts, hertz, amps, degrees, sine wave or square wave
WVF		SNW,SQW	Waveform
OPN			Open output relays (2001L,1501L, 751L if option installed)
CLS			Close output relays (2001L,1501L, 751L if option installed)
VLT			Used with TLK to request measurement of the output voltage.
ELT			Used with TLK to request total accumulated run-time.
CUR			Used with TLK to request measurement of the output load current.
PWR			Used with TLK to request measurement of the True output power.
APW			Used with TLK to request measurement of the Apparent output power
PWF			Used with TLK to request measurement of the output power factor.
PZM			Used with TLK to request measurement of the output phase angle
FQM			Used with TLK to request measurement of the output frequency.

3.6.5 TO PROGRAM OUTPUT VOLTAGE AMPLITUDE (AMP)

The AMP header is used to identify the amplitude command. The argument is a numeric data field from 0.0 to the limit set by the RNG value. An attempt to program a value higher than this value will generate an error and a SRQ on the GPIB.

The following ASCII strings will program the voltage given in the left column:

0.0 volts	AMP0
10.5 volts	AMP10.5 or AMP1.05E1 or AMP105E-1
100 volts	AMP100 or AMP100.0 or AMP1E2

3.6.6 TO PROGRAM FREQUENCY (FRQ)

The FRQ header is used to identify the following numeric data as frequency.

The following string will program the frequency to 60.56 Hz.

```
FRQ 60.56
```

3.6.7 TO PROGRAM PHASE ANGLE (PHZ)

The PHZ header is used to identify the following numeric data as phase. The phase output will lead the external sync signal by the value programmed.

The following example will program the output phase angle to 90 degrees relative to external sync if it was operating in the external sync mode.

```
PHZ 90
```

3.6.8 TO PROGRAM CURRENT LIMIT (CRL)

The CRL header is used to identify the Current Limit Command. The argument is a numeric data field from 0.0 to the maximum rated current of the power system.

The following string will program a current limit of 10.5 amps.

```
CRL 10.5
```

3.6.9 TO PROGRAM TOTAL HARMONIC DISTORTION (THD)

The THD header is used to identifiy the total harmonic distortion. The argument is a numeric data field form 0 to 20. The following string will program the output for 115 volts and the total harmonic distortion for 10%.

AMP 115 THD 10

3.6.10 TO PROGRAM HOLD OFF COMMAND (HLD)

The HLD header is used to identify the hold off command. The hold off command is accessible through the GPIB. It will delay the response to a fault condition resulting from the output current exceeding the programmed current. The hold off command has a maximum value of 1 second. in 10 ms increments. Default is 100 msc.

3.6.11 TO PROGRAM RAMP OR STEP OPERATIONS

The DLY header is used with a parameter that has a numeric argument (ex. AMP, FRQ, PHZ, CRL, CAL) in a single step program. The numeric argument is in seconds with four decade resolution from 0.001 to 9999 seconds.

The STP header with VAL may be used with DLY to completely specify a ramp program.

The following string will first step the voltage to 125 volts for 2.55 seconds and return to 115 volts.

AMP 125 DLY 2.55 VAL 115

The following string will ramp the voltage from 10 volts to 115 volts with 1.5 volt/.5 sec. steps:

AMP 10 DLY .5 STP 1.5 VAL 115

When an AMP header with an argument of 0 is used, the waveform will stop and drop to zero volts at the point specified by the PHZ value.

The following ASCII string will stop the waveform at 0 degrees for .01 seconds and return to 115 volts:

PHZ 0 AMP 0 DLY .01 VAL 115

The STP header is used to identify the following argument numericvalue as the increment or decrement value for a FRQ, CRL, AMP, PHZ or CAL ramp.

The following example will ramp the output from 130 volts in 1.5 volt/.5 sec. steps to 10 volts.

AMP130 DLY.5 STP1.5 VAL10

The header VAL is used to identify the following numeric argu-ment as the final Value of a ramp or step. If the VAL argument is larger than the initial value for the parameter to be ramped, the ramp will increment with step size defined by STP and DLY. With the VAL argument less than the initial value, the ramp will decrement from the initial parameter.

A ramp or step operation can be stopped at anytime by the GPIB message Group Execute Trigger (GET).

The following example will decrement the output amplitude from 120 in .1 volt/.2 sec steps to 100 volts after a Device Trigger.

AMP 120 DLY.2 STP.1 VAL100 TRG

The following example will ramp the Frequency from 400 to 5000 Hz at a rate of 10 Hz per second and the Amplitude from 5 volts
in increments of .5 volts per step:

RNG270 AMP5 FRQ400 STP10 DLY1 VAL5000 STP.5

A GPIB Service Request will be generated at the end of a ramp if SRQ2 is included in the setup string.

3.6.12 TO PROGRAM A REGISTER (REG)

The REG header is used to load the register specified by the following numeric data with the preceding data. The numeric value is from 0 to 15. The PRG header is identical to the REG header and is included to standardize other AC power controllers.

The following example will load a ramp program that will step
the voltage from 10 to 115 volts with 1 volt/.5 sec steps at 400
Hz into register 0.

FRQ400 AMP10 DLY.5 STP1 VAL115 REG0

3.6.13 TO RECALL A REGISTER (REC)

The REC header is used to recall previously loaded data from a register identified by the following register number (0 to 15).

The following example recalls and outputs the parameters stored in register 0 by an example in paragraph 3.6.11.

REC0

The following example recalls the parameters in register 0 and outputs the parameters after the IEEE-488 "GET" message.

REC0 TRG

The following is an example of register linking. The voltage and frequency is maintained at 115 volts and 60 Hz for 5 seconds and then the program contained in register 0 is recalled and executed. The program is stored in register 1.

FRQ60 AMP115 DLY5 VAL115 REC0 REG1

The program is initiated by the following ASCII string:

REC1

3.6.14 TO PROGRAM VOLTAGE RANGE (RNG)

The RNG header is used to select a range. The numeric value following the RNG header will also define the upper limit for the AMP value. The RNG value will select the higher range if the value is greater than the lower range value defined by the ALM screen which is 135 for the standard voltage range. If the range and voltage amplitude are to be programmed by the same data string the RNG header and argument must precede the AMP header or a syntax error will be generated.

The following example will select the 270 range from the 135/270 range pair with an upper amplitude limit of 210 volts.

RNG210

3.6.15 TO PROGRAM EXTERNAL SYNCHRONIZATION (SNC)

The SNC header is used with the EXT argument to synchronize the output to an external sync input. The output will be phase referenced to the sync input with the displacement equal to the PHZ value.

The following ASCII string will program the output phase to 0 degree relative to the external sync input and select the external sync mode.

PHZ0 SNC EXT

Sending the ASCII string SNC INT will disable the sync input.

3.6.16 TO PROGRAM A NUMBER OF DROP PERIODS (DRP)

The DRP header is used to identify the drop command. The argument is a numeric data field from 1 to 5 that sets the number of Drop periods. the start angle of the Drop is defined by the value of phase A angle.

The following ASCII string will Drop the output voltage for 5 cycles starting at 90° angle of the sinewave.

PHZ 90 DRP 5

3.6.17 TO PROGRAM INITIAL VOLTAGE RANGE (ALMA)

The ALM header is used to identify the Amplitude Range value. It must be followed by extension A. The argument is a numeric value. This value must have the range 0 to 15. The only acceptable value that does not generate a Range Error is the value equal ±8 from the existing value.

If ALMA = 0, the following string will initialize the power source to the high voltage range at power up.

ALMA8

3.6.18 TO PROGRAM INITIAL FREQUENCY VALUE (FLMA)

The FLM header is used to identify the initial frequency if it is followed by extension A and numeric value within the frequency range of the power source.

The following string will cause the power source to initialize at 400 Hz at power up.

FLMA400

3.6.19 TO PROGRAM INITIAL AMPLITUDE VALUE (INIA)

The INI header is used to identify the initial Amplitude values if it is followed by extension A. The initial value is limited from 0 to 5 volts. The following string will program the power source to initialize at 5 volts at power up.

INIA 5.0

3.6.20 TO PROGRAM INITIAL CURRENT LIMIT VALUE (INIC)

The INI header is used to identify the initial Current Limit value if it is followed by extension C. The initial value must be within the current limit of the power source. The following string will program the power source to initialize its Current Limit to 5.5 Amps at power up.

INIC 5.5

3.6.21 TRIGGER AN OPERATION (TRG)

The TRG header has no argument. When the TRG mnemonic is included in a setup string, it will delay execution of the string until the GPIB Device Trigger message is sent by the bus controller.

The TRG header may also be used to trigger register operations by including the TRG header with the string used to recall a register. The following example will delay execution of the program in register 1 until an IEEE-488 Device Trigger is received:

REC1 TRG

The Trigger mode may also be enabled in the local mode by pro-gramming setup parameters without depressing the ENT key. The setup values will then be programmed in the remote mode when the Device Trigger is received.

3.6.22 TO PROGRAM TO OUTPUT WAVEFORM (WVF) (Optional)

The header WVF is used to identify the following argument as the Sine Wave (SNW) or Square Wave (SQW) function of the Waveform.

The following example will program the output to the square wave function.

WVF SQW

The following example will program the output to the sine wave function:

WVF SNW

3.6.23 TO OPEN (OPN) AND CLOSE (CLS) THE OUTPUT RELAY (Option in 751L)

The OPN and CLS headers open and close the output relays in the power source. There is no argument associated with these headers. When the OPN or CLS headers is received the output voltage will be programme to initial value for 50 milliseconds before the output relays open or close.

3.6.24 TO TALK (TLK) MEASURED AND PROGRAMMED DATA

The TLK header will setup the AC Power Source to talk data. The TLK header will setup the AC Power Source to report a programmed output parameter if the program header is the argument for the TLK header.

To setup the AC Power Source to report a measured value, attach a measurement header to the TLK argument. The measurement headers are VLT, CUR, PWR, APW, PWF and FQM.

The following string will setup the AC Power Source to measure the power output when it is talk addressed:

TLK PWR A

All arguments for the TLK header are shown in Table 3-13. Table 3-14 shows an example response for all TLK arguments with no A, B or C extension.

TABLE 3-13

TLK ARGUMENTS

ARGUMENT	EXTENSION	DATA REPORTED	DEFINITION
ALM	A B C	0000 *135.0 *270.0	Default voltage range code Low Voltage Range High Voltage Range
AMP		0 to 270.0	Programmed voltage Amplitude value in volts.
APW		0 to 2000	Output VA
CFG	A B C	0 to 30 * 188 * 0	IEEE-488 Listen Address Configuration Code Phase C initial Value - output configures.
CLM	A B C	Maximum 35°C Current 0 2	Defines the maximum current Defines the power decimal point Defines the current decimal point
CRL	A,B,C	0 to Max. Current	Programmed output current limit.
CUR	A,B,C	0.00 to 20.0	Output current
ELT	A B C	0000 to 9999 00 to 59 00 to 59	Total accumulated hours (H) Accumulated minutes (M) Accumulated seconds (S)
FLM	A B C	60 45 550	Default frequency Low frequency limit High frequency limit
FQM	None	45.00 to 550	Measured output frequency
FRQ	None	45.00 to 550	Programmed frequency
INI	A C	0.0 TO 5.0 O to CLMA	Default voltage Default current limit

(*) Standard values shown. Values will be different for other ranges, output power and options.

TABLE 3-13 (CONTINUED)

TLK ARGUMENTS

ARGUMENT	EXTENSION	DATA REPORTED	DEFINITION
CLK	None	INT or EXT	Programmed clock source
SNC	None	INT or EXT	Programmed external sync mode
WVF		INT or EXT	Programmed waveform
PHZ		0.0 to 359.9	Programmed output phase angle
PWR		0 to 2000	Output watts
PZM		0 to 359.9	Measured phase A angle relative to external sync
REG	0 to 15	Contents of Reg	Talk contents of register
RNG	None	0 to 270.0	Programmed range and limit
SRQ	None	0, 1 or 2	Programmed SRQ status
VLT		0.0 to 270.0	Measured output voltage

TABLE 3-14

EXAMPLE TALK RESPONSE

ASCII STRING	SENT	RESPONSE AFTER	ADDRESSED TO TALK
TLKALM	ALMA0000	B135.0	C270.0
TLKAMP	AMPA005.0		
TLKAPW	APWA1003		
TLKCFG	CFGA0001	B0028	C0120
TLKCRL	CRLA12.34		
TLKCUR	CURA06.14		
TLKELT	ELTH0147	M0051	S0033
TLKFLM	FLMA0060	B0045	C0550
TLKFQM	FQM59.97		
TLKFRQ	FRQ60.00		
TLKCLK	CLK INT (*)		
TLKSNC	SNC INT		
TLKPHZ	PHZA000.0		
TLKPWF	PWFA1.000		
TLKPWR	PWRA0.737		
TLKPZM	PZMA000.0		
TLKREG0	ACTUAL CONTENTS OF REGISTER 0		
TLKRNG	RNGA 135.0		
TLKVLT	VLTA120.1		
TLKWVF	WVFA SNW		
TLKINI	INIA005.0	C012.34	

(*) If function is not enabled, a syntax Error message will be generated

3.6.25 TO TALK THE MEASURED OUTPUT VOLTAGE (TLK VLT)

VLT may be used as an argument to the header TLK. When used as an argument, it will set up the AC Power Source to measure the output voltage with 0.1 volt resolution.

When VLT is used as a header in a string with no argument, it will cause the front panel to display the measured output voltage.

3.6.26 TO TALK THE MEASURED OUTPUT CURRENT (TLK CUR)

CUR may be used as an argument to the header TLK. When used as an argument, it will set up the AC Power Source to measure the output current in amps with 0.01 amp resolution.

When CUR is used as a header in a string with no argument, it will cause the front panel to display the output current.

3.6.27 TO TALK THE MEASURED OUTPUT POWER (TLK PWR)

PWR may be used as an argument to the header TLK. When used as an argument, it will set up the AC Power Source to measure the output power in watts with 1 watt resolution.

When PWR is used as a header in a string with no argument, it will cause the front panel to display the output power.

3.6.28 TO TALK THE MEASURED OUTPUT POWER FACTOR (TLK PWF)

PWF may be used as an argument to the header TLK. When used as an argument, it will set up the AC Power Source to measure the output power factor from 0 to 1.000.

When PWF is used as a header in a string with no argument, it will cause the front panel to display the output power factor.

3.6.29 TO TALK THE MEASURED OUTPUT APPARENT POWER (TLK APW)

APW may be used as an argument to the header TLK. When used as an argument, it will set up the AC Power Source to measure the Apparent Power output in VA with 1 VA resolution.

When APW is used as a header in a string with no argument, it will cause the front panel to display the measured output Apparent Power.

3.6.30 TO TALK THE MEASURED OUTPUT FREQUENCY (TLK FQM)

FQM may be used as an argument to the header TLK. When FQM is used as an argument, it will set up the AC Power Source to measure the output frequency in hertz.When FQM is used as a header, it will cause the front panel to display the measured output frequency.

3.6.31 TO TALK THE MEASURED OUTPUT PHASE ANGLE (TLK PZM)

PZM may be used as an argument for the header TLK. When used as an argument, PZM will set up the AC Power Source to measure the phase angle of phase A relative to external sync. The measure-ment is made at the Remote Sense terminals. Phase A will always be reported as 000.0 degrees unless the AC Power Source is oper-ating in the external sync mode.

When PZM is used as a header, it will cause the front panel to display the phase measurement screen.

3.6.32 MESSAGE SEPARATORS

A complete message consists of a header and an argument. Since more than one message can be sent in a setup string, message separators included in the string between the message will make it more readable to the human operator. Three message separators are recognized: the comma (,), semicolon (;) and a space. Since these separators are ignored, they may be dispersed throughout a setup string.

The following are two examples of ASCII strings with separators:

PHZA90;FRQ60;AMP115

CRL,90;FRQ50;AMP,120

3.6.33 SERVICE REQUEST

After power-up the GPIB Service Request (SRQ) will be generated after any error (example. syntax, output fault, etc.). This SRQ output can be inhibited by the SRQ header followed by the single digit "0". The SRQ can be reenabled by the SRQ header followed by 1. Sending SRQ2 causes an SRQ to be generated after the execution of a setup string. The setup string can be of any type: ramp, calibration, etc.

The following example disables GPIB SRQ.

SRQ0

3.6.34 SERIAL POLL STATUS BYTE

Once the bus controller has detected the SRQ, it must determine the instrument needing service by the Serial Poll. During the polling routine the instrument needing service will return a Status Byte (STB) greater than decimal 63. The Status Byte values for various faults are given in Table 3-15.

3.6.35 END OF STRING

The End of String (EOS) delimiter recognized by the AC Power Source is the ASCII Line Feed (LF). Carriage Return (CR) followed by Line Feed may also be used for EOS. The End or Identify (EIO) IEEE-488 message END will also be recognized. The END message is sent by setting the IEEE-488 End or Identify line true with the last data byte.

3.6.36 ERROR MESSAGES

Table 3-15 shows all of the possible error messages that can be generated by the AC Power Source. These messages will also be displayed on the front panel of the AC Power Source.

3.6.37 GROUP EXECUTE TRIGGER

The trigger mode is enabled when the mnemonic TRG is added to a setup string. The trigger command may be inserted anywhere in he string. When the mnemonic is detected, it will delay execution of the new setup values until the GPIB Device Trigger is sent by the bus controller.

A GPIB Device Trigger will also terminate a programmed ramp or other program.

The following setup string will recall the values from register 9 and delay execution until the GET message is received.
(Note: GET is the abbreviation for the GPIB Group Execute Trigger mes-sage and does not represent a series of ASCII characters. (See Table 3-10).

REC9TRG

TABLE 3-15

STATUS BYTE VALUES

STATUS BYTE SRQ = 1	REPORTED MESSAGE	CAUSE
64	AMP A FAULT	Overload or sense line fault
72	TEMP A FAULT	Amplifier overtemperature
90	RNG RANGE ERROR	RNG value greater than 270.0
91	AMP RANGE ERROR	AMP value greater than RNG value
92	FRQ RANGE ERROR	FRQ value is less than 45 or greater than 550
93	PHZ RANGE ERROR	PHZ value greater than ±999.0
94	CRL RANGE ERROR	CRL value greater than maximum value
95	RMPA RANGE ERROR	DLY, STP or VAL values wrong
96	SYNTAX ERROR	Wrong string SYNTAX
97	BUS LOCAL ERROR	Remote message sent while in local mode
98	EXT SYNC ERROR	No external sync input or signal not between 45 and 5000 Hz
99	CPU MEMORY FAULT	CPU failed self-test
100	DMA OVERFLOW ERROR	Remote message greater than 256 bytes
101	CAL RANGE ERROR	Unable to calibrate output
127		The response after SRQ2 is included in a setup string and the execution of the string has been completed.
40	STA OK	No problems

4 CALIBRATION PROCEDURE

4.1 GENERAL

The calibration is divided into two categories; a periodic and a nonperiodic calibration. The periodic calibration should be performed at a 1 year interval. The nonperiodic calibration should only be performed if the periodic calibration cannot be performed or if an adjustable subassembly is replaced.

The following is a listing of paragraphs that may be performed to fix an indicated problem.

PARAGRAPH	TITLE
4.3.1	OUTPUT VOLTAGE CALIBRATION This is a periodic calibration of the output voltage.
4.3.2	MEASUREMENT CALIBRATION This is a periodic calibration of the measurements of output voltage, current and power.
4.3.3	REMOTE MEASUREMENT CALIBRATION
4.3.4	REMOTE OUTPUT VOLTAGE CALIBRATION
4.4.1	OUTPUT FREQUENCY CALIBRATION This is a nonperiodic calibration of the output frequency.
4.4.2	GAIN ADJUSTMENTS These are nonperiodic adjustments of the Current Limit Board, assembly A5. The adjustments may have to be performed for the following reasons: 1. An output amplifier, assembly A7 is replaced.
4.3	CURRENT TRANSFORMER ADJUSTMENTS These are nonperiodic adjustments. The adjustments are required if it is impossible to perform the current or power measurement calibration. (Ref. Paragraph 4.3.2).
4.4	CURRENT LIMIT CALIBRATION This is a nonperiodic calibration. The calibration is required if the available output current is not equal to the programmed current limit value. The available output current may exceed the programmed value by 10%.

4.2 TEST EQUIPMENT

The following equipment or their equivalents are required to completely test the AC Power Source.

TEST EQUIPMENT FOR PERIODIC CALIBRATION

1. Digital Voltmeter: Fluke Model 8840A (modified per CIC005) or equivalent.

2 50 Amp Current Transformer: Pearson Model 110

3. Resistive Load: Refer to Table 4-1 for load values.

ADDITIONAL TEST EQUIPMENT

1. Frequency Counter: Philips PM 6671

4.3 PERIODIC CALIBRATION

The following periodic calibration adjustments should be performed on a 1 year interval.

4.3.1 OUTPUT VOLTAGE CALIBRATION

For the following adjustments, remove all loads from the output. The "External Sense" inputs must be connected. Refer to Figure 4-1.e stabilization. Program the output to 60 Hz, 135 volts and perform the following steps:

1. Connect the AC DVM to the output of the Power Source.

2. Program 135.0 volts and 400 Hz. Adjust A5R38 on the Current Limit Board for 135.0 ±0.1 V rms.

3. Program 60 Hz. Adjust R39 on the phase A board of the oscillator for 135.0 ±0.05 V rms.

4. Repeat steps 2) and 3) until the output is within 135.0 ±0.1V rms without readjustment.

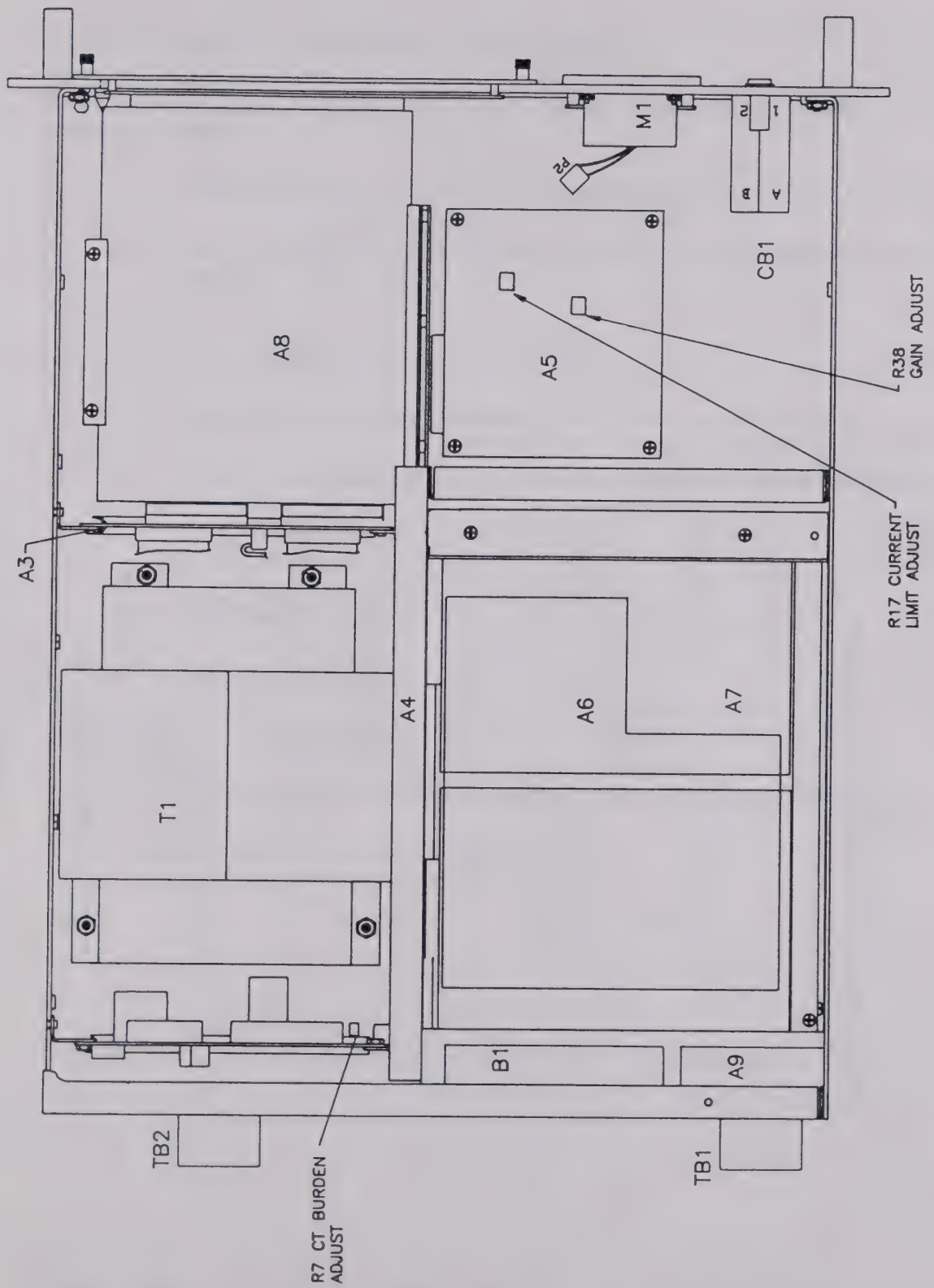


FIGURE 4-1
INTERNAL ADJUSTMENTS AND JUMPER LOCATIONS

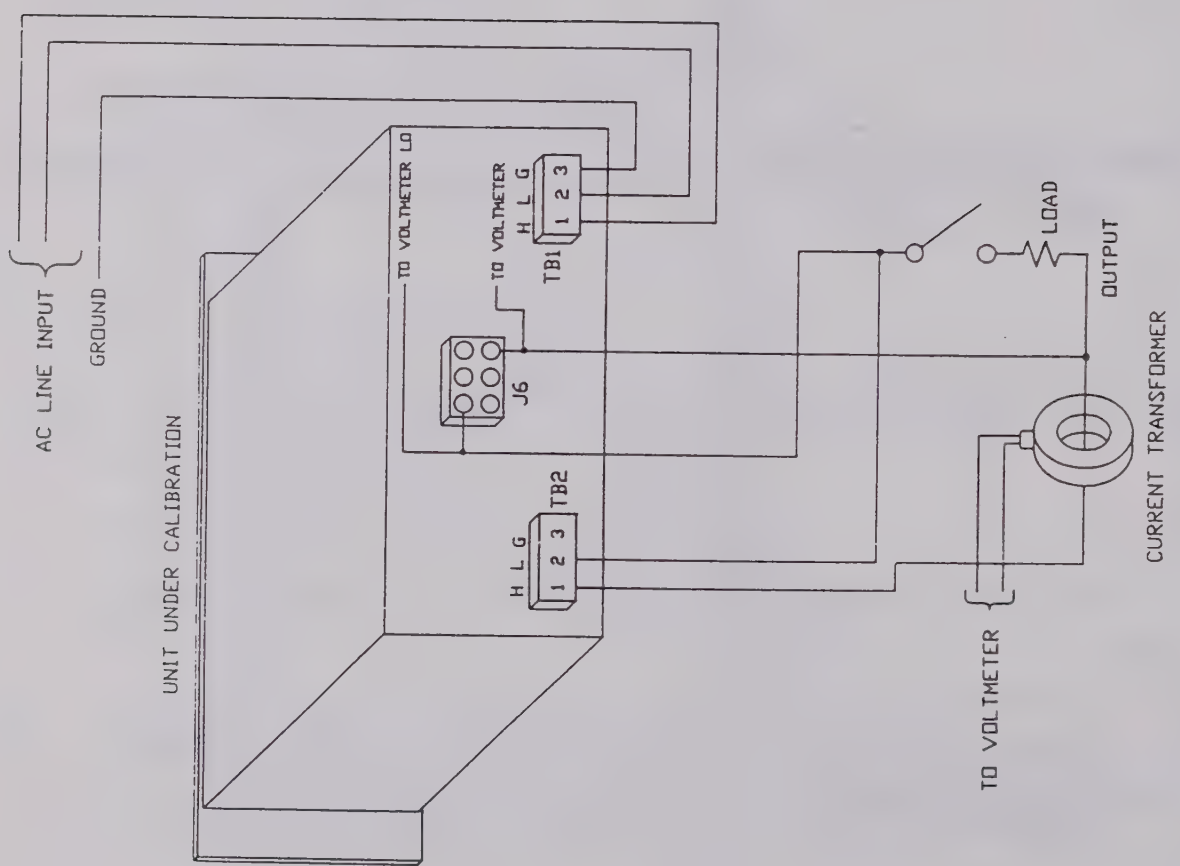


FIGURE 4-2
EQUIPMENT HOOKUP FOR
PERIODIC CALIBRATION

4.3.2 VOLTAGE MEASUREMENT CALIBRATION

For calibration of voltage measurement first perform the output voltage calibration and then perform the followings steps:

1. Remove the load from the AC Power System and program 60 Hz and 135.0 volts.

2. Depress the MNU key several times until the Menu screen is displayed as illustrated below:

   THD = 00 SNC = 01
   DRP = 02 *WVF = 03

3. Enter the key sequence: 959 ENT.

4. Depress the MNU key several times until the configuration menu screen is displayed.

   CFG = 16 ALM = 17
   FLM = 18 CLM = 19

5. Enter the key sequence 13 ENT to access the CAL VLT screen.

6. Enter the key sequence:

   135 PRG ENT

   After about 5 seconds, the volt measurement function will be calibrated.

Table 4-1: Configuration and Setup Value 1

MODEL		STANDARD	LV	HV	EHV
VOLTAGE RANGE		135/270	67.5/135	156/312	200/400
LOAD	2001L	9.1Ω	2.3Ω	12.2Ω	20Ω
	1501L	10.9Ω	2.73Ω	14.59Ω	24Ω
RESISTORS	751L	21.8Ω	5.45Ω	29.1Ω	47.9Ω
CLM A	2001L	14.8	29.6	12.8	10
(MAXOUTPUT)	1501L	12.34	24.70	10.68	8.84
AMPS	751L	6.18	12.37	5.36	4.18
PROGRAM VALUE	2001L	12	24	10	9
	1501L	10	20	7.4	6.6
FOR CAL.	751L	5	10	3.7	3.3
CURRENT LIMIT	2001L	12.6	25.2	10.5	9.5
	1501L	10.7	21.4	8	7
SET POINT	751L	5.4	10.7	4	3.5

4.3.3 CURRENT MEASUREMENT CALIBRATION

For calibration of current measurement perform the following steps:

1. Program 60 Hz, 135.0 volts and the maximum Current Limit value.

2. If any calibration screen is already displayed, the Current Calibration screen (CAL CUR) may be displayed by repeatedly depressing either the MON or PRG keys and then skip to step 6. If a calibration screen is not displayed, press the MNU key several times until the screen shown below is displayed:

   THD = 01 SNC = 01
   DRP = 02 *WVF = 03

3. Enter the key sequence: 959 ENT

Note (*) : May not be displayed. Depends on configuration.

4. Depress the MNU key several times until the configuration menu screen is displayed, as shown below:

   CFG = 16 ALM = 17
   FLM = 18 CLM = 19

5. Enter the key sequence: 14 ENT to access the CAL CUR screen.

Determine the full load resistive value from the LOAD RES value in Table 4-1.

6. Apply the full load to the output. For other voltage ranges consult Table 4-1. Measure the output current with the AC Digital Voltmeter and Current Transformer.

7. On the keypad enter the key sequence:

   Measured current. PRG ENT
   Example: "12.1 PRG ENT"

   After about 5 seconds the current measurement function will be calibrated.

4.3.4 POWER MEASUREMENT CALIBRATION

For calibration of power measurement perform the following steps:

1. Program 60 Hz and 135.0 volts and the maximum Current Limit value.

2. If any calibration screen is already displayed, the Power Calibration screen (CAL PWR) may be displayed by depressing either the MON or PRG keys and then skip to step 6. If a calibration screen is not displayed, depress the MNU key several times until the screen shown below is displayed:

THD = 00	SNC = 01
DRP = 02	*WVF = 03

3. Enter the key sequence: 959 ENT

4. Depress the MNU key several times until the configuration menu screen is displayed as shown below:

CFG = 16	ALM = 17
FLM = 18	CLM = 19

5. Enter the key sequence 15 ENT to access the CAL PWR screen.

6. Apply the LOAD RES value from Table 4-1 to the output. Measure the output current with the AC Digital Voltmeter and Current Transformer. Measure the voltage from the sense HI to neutral sense. Multiply the voltage and current values to determine the power value. (Note: The load must be resistive for the correct power value.)

7. On the keypad enter the key sequence:

   (Measured power) PRG ENT

4.3.5 REMOTE MEASUREMENT CALIBRATION

The measurement function of the AC Power Source may be remotely calibrated. The equipment hookup is the same as before except an IEEE-488 Controller must be used to program the AC Power Source. The values for the VLT, CUR and PWR strings must be derive from the external AC Digital Voltmeters and Current Transformer.

To calibrate the measured voltage, first program the AC Power Source to 135.0 volts and 60 Hz. Send the following calibration string:

CAL VLT (Measured output voltage value)

To calibrate the measured current send the following string:
CAL CUR (Measured output current value)

To calibrate the measured power value send the following string:

CAL PWR (Measured output power value)

4.4 NONPERIODIC CALIBRATION

If adjustments are required for these nonperiodic calibrations, the top cover of the AC Power Source will have to be removed. A nonperiodic calibration will only be required if a related assem- bly is replaced or if the performance is out of specification.

4.4.1 OUTPUT FREQUENCY CALIBRATION

Connect the Frequency Counter to the output. Program the output to 135.0 volts and 400.0 Hz. Engage the low-pass filter on the Frequency Counter to obtain the output frequency.

If the Frequency Counter does not indicate 400.000 ±0.004 Hz, adjust C43 on the A8 Assembly for the correct frequency. Refer to Figure 4-1.

4.4.2 CURRENT TRANSFORMER ADJUSTMENTS

1. Monitor the output current with the Current Transformer and AC DVM. Measure the sense voltage between TP10 and TP1(GND) on the Current Limit Assembly (5). Refer to Figure 4-1.

2. Turn on the AC input to the AC Power Source. Program 135.0 VRMS and 60 Hz.

3. Apply the resistive load to the output. Adjust R7 on the Range Relay assembly, A2, for the correct voltage at TP10 for the load current: (1 volt = 10 amps). Remove the load.

4.4.3 CURRENT LIMIT CALIBRATION

1. Program the Current Limit to 10.0 amps. (1501lL)

2. Monitor the phase A output current with the external current transformer and AC voltmeter.

3. Program the output voltage to 110 volts and 60 Hz.

4. Apply the LOAD RES to the output. If the output faults turn A5R17 on the Current Limit Assembly clockwise and reprogram 110 volts.

5. Increase the output amplitude slowly until the external AC current transformer indicates 10.7 amps. Slowly turn A5R17 on the Current Limit Assembly in a counterclockwise direction until the output faults.

5 THEORY OF OPERATION

5.1 GENERAL

An explanation of the circuits within the AC Power Source is given in this section. Refer to Figure 5-1 for the block diagram of the AC Power Source.

5.2 OVERALL DESCRIPTION

Input power at the rear panel is routed through the EMI filter and circuit breaker to the high current rectifier and the Power Supply Assembly, A6. The various DC supply outputs then go to the Mother Board, A4, then are directed to other modules.

The Programmable Oscillator Assembly, A8, generates the oscillator waveforms, power source controls and measurement signals. The oscillator assembly is connected to the rest of the power source through the Oscillator Interface Board, A3.

The Amplifier Module, A7, takes its DC supply voltages and input signal from the Mother Board, A4. It produces the high power output for the primary of the output transformer, T1. The output is routed through the Mother Board to the output transformer.

The Range Relay Board is identified as A2. This board assembly configures the secondaries of the output transformers for the correct output voltage range. The output from the AC Power Source is taken from the Range Relay Board.

The Current Limit Board is identified by A5. This board controls the amplifier gain and the programmable current limit.

5.3 INPUT POWER SUPPLY

This assembly is identified as A6. It generates the high power +300 VDC supply.

The input power supply also has circuits that generate auxillary DC voltages identified as ±18V, ±15VSW, +8VSW and +8V.

The ±18V supplies are used for oscillator modules and the Current Limit Board. The +8V supply is used for the oscillator module. The ±15VSW and +8VSW supplies are used for the Amplifier Module.

The input power supply also generates 50 VDC and 15VSW1 from the 300 volt DC supply. The 50 VDC is used for fan and relay operation, +15VSW1 is used for the gate drive signal in the Amplifier Module.

5.4 CURRENT LIMIT BOARD

The Current Limit Board receives the oscillator signal from the Oscillator Module. The signal is directed to the input of the power amplifier. A gain adjustment is located on the board.

The current limit circuit is also located on the Current Limit Board. The circuit receives a DC signal from the Oscillator Module that is proportional to the current limit value. The DC signal is compared to the output current.

If the output current exceeds the programmed value, an attenuator will limit the output voltage to a value that will cause the AC Power Source to operate at a constant current. If the output current limits the output voltage to 90% of the programmed voltage, an amplitude fault will be generated.

5.5 INDICATOR BOARD

The Indicator Board, A1, has LED indicators for the HI RANGE, OVERTEMP and OVERLOAD conditions.

5.6 RANGE RELAY BOARD

The Range Relay Board has all of the AC Power Source relays. These relays are operated from +50 VDC. The output relay, if the option is installed, is controlled by the CNF Logic Line. The range relay is controlled by RNG HI line.

There is a current transformer on the Range Relay Board. This transformer generates an AC voltage that is proportional to the output current. A 10 amp load current is represented by 1.00 VAC at the output of the current transformer.

5.7 AMPLIFIER MODULE

The AC Power Source has a switchmode amplifier module to obtain high efficiency. The switchmode amplifier operates at 200 KHz.

The Amplifier Module obtains its input signal from the Current Limit Board. A 5.0 VRMS input signal will generate a full scale output voltage at the output of the AC Power Source and 100.0 VRMS on the primary of the output transformer.

The Amplifier Module requires a 300 VDC, ±15VSW, +8VSW and +15VSW1 supplies. The +300 VDC supply comes from the input power supply through a 15 amp fuse.

The Amplifier Module has a thermoswitch mounted on its heatsink.

If the heatsink temperature exceeds 100 degrees C, the amplifier shuts down and sends an OVT signal to the oscillator module. A logic low on the OVT control line will cause the error message TEMP FAULT to be generated.

5.8 OSCILLATOR MODULE

The Oscillator Module is identified with the reference designator, A8. The module consists of two printed circuit assemblies.
These assemblies are interconnected with a small Mother Board. The Oscillator Display Assembly is mounted to the small Mother Board and is connected to the Oscillator Module with a short ribbon cable. The Oscillator Module is a plug in module from the AC Power Source front panel.

5.9 CPU/GPIB BOARD

The CPU/GPIB board, A8A3, provides the control and measurement functions of the module. A microprocessor circuit accepts commands from the GPIB or the front panel keyboard. It sends digi tal programming information to set the output parameters of the power source. Data from measurement circuits are accepted and reported to the display and GPIB. Measurement calibration coefficients are stored in a memory backed up by a battery. The battery has a 10 year life expectancy.

Measurement circuits on the CPU/GPIB board monitor voltage, current, power, frequency, and phase angle. Voltage from the rear panel sense connector is scaled, converted to a DC voltage by a true-rms-converter, and sent to the microprocessor by the analog-to-digital converter.

Current sensed by internal current transformers is scaled, converted to a DC voltage by a true-rms-converter, and sent to the microprocessor by the analog-to-digital converter.

The scaled voltage and current waveforms are applied to the inputs of a multiplier. The multiplier output is filtered to a DC level and digitized by the analog-to-digital converter.

Frequency is computed from the measured time intervals between zero crossings of the output waveform. Phase is computed from the differences of measured zero crossings between the output signal and the external sync signal, if it is enabled.

A digital-to-analog converter on the CPU/GPIB board sets the DC voltages that are used for the programmable current limit function.

5.10 PHASE A/REF BOARD

The Phase A/Ref Board, A8A5, serves several purposes. A program- mable clock sets the output frequency of the power source.

Digital-to-analog converters program references to set the output amplitude. A sine wave generator creates a 1024 step waveform which is filtered to provide the output oscillator signal. A remote sense amplifier controls the output amplitude.

5.11 DISPLAY MODULE

The Display Board, A8A13, is held to the power source by a small panel and is connected through a short ribbon cable. It holds the 20 button keyboard and a 32 character LCD display. A knob on the board allows the display viewing angle to be adjusted.

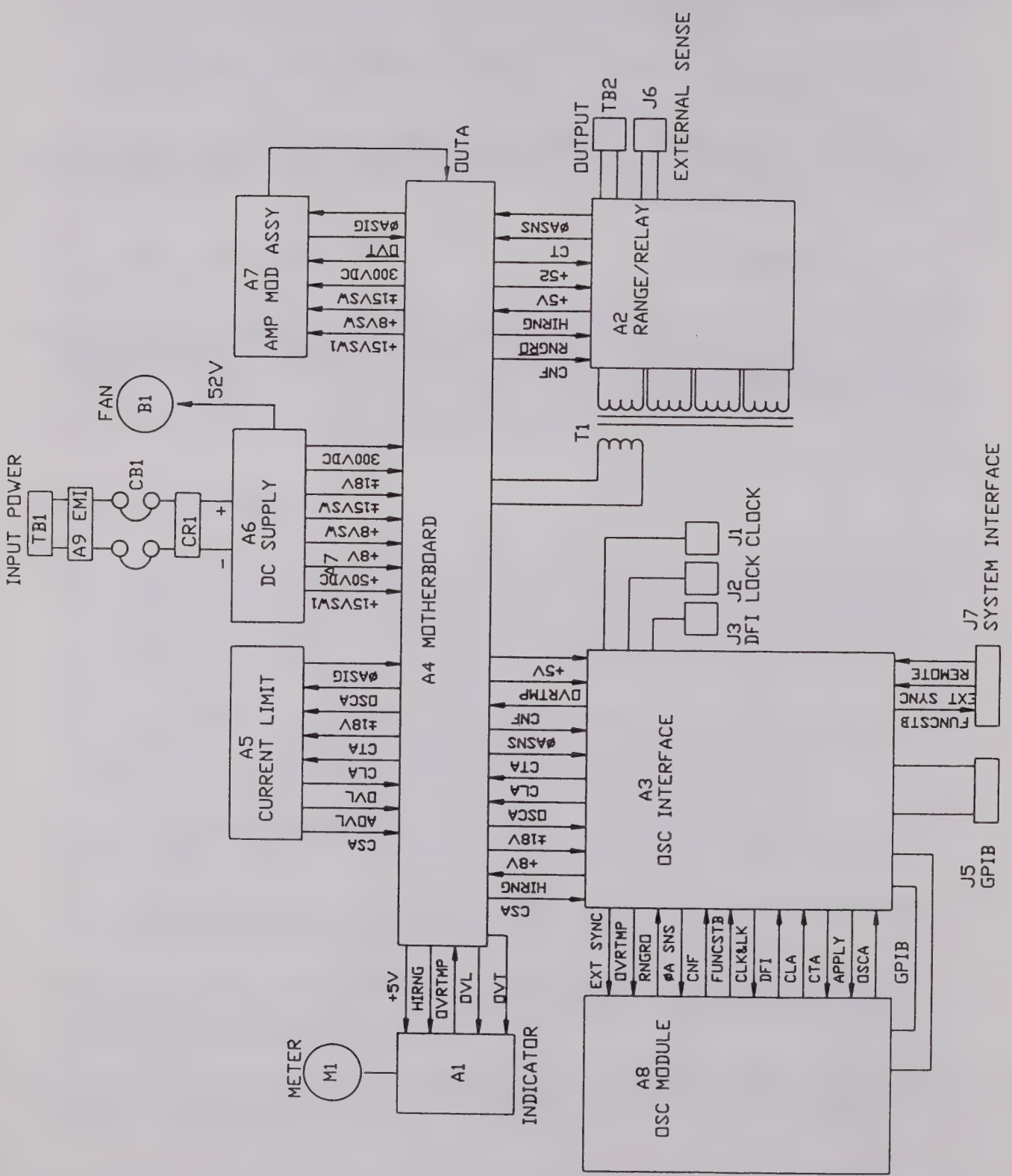


FIGURE 5-1
AC POWER SYSTEM BLOCK DIAGRAM

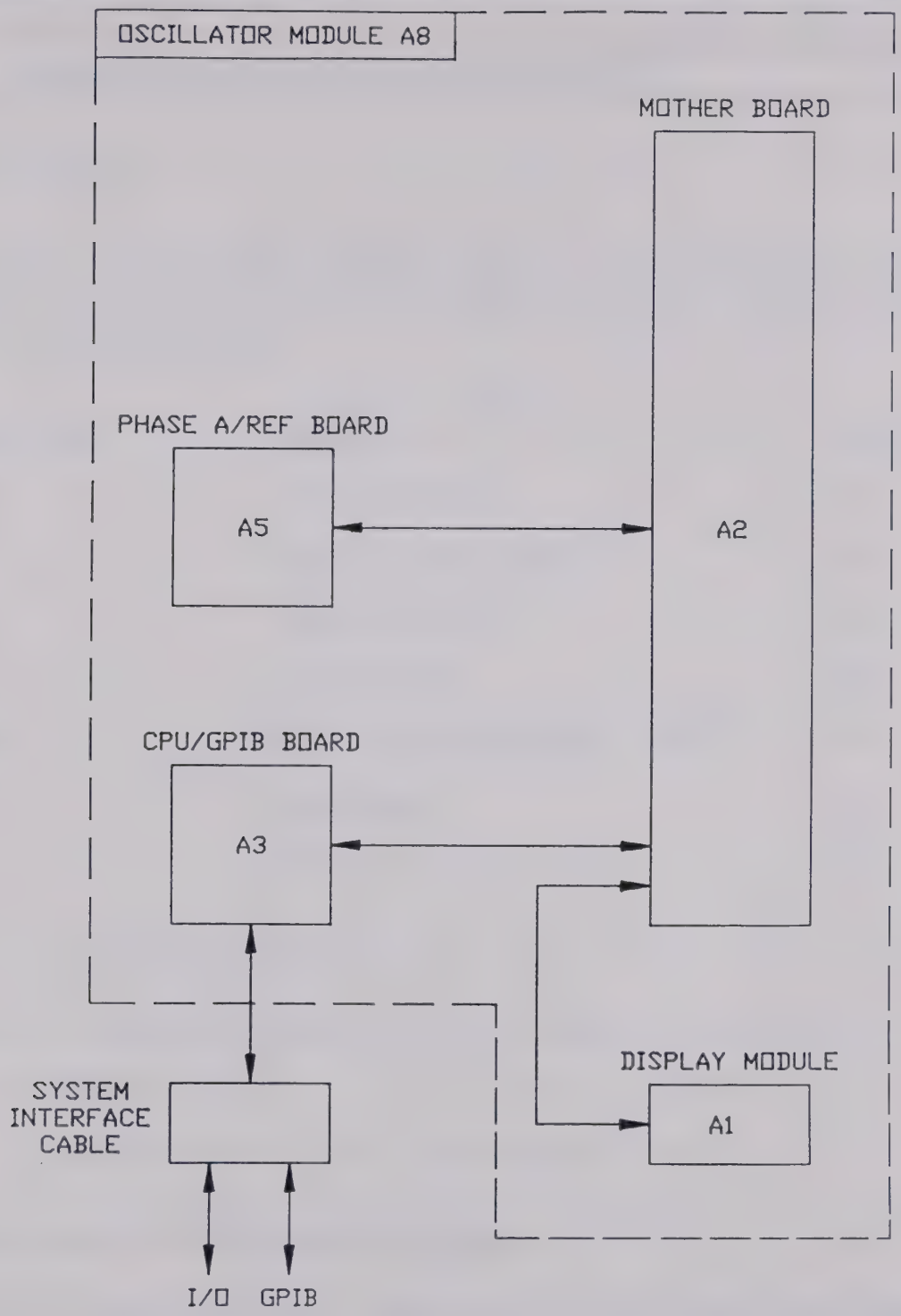


FIGURE 5-2
PROGRAMMABLE OSCILLATOR MODULE

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6 MAINTENANCE AND TROUBLESHOOTING

6.1 GENERAL

This section describes the suggested maintenance and trouble- shooting procedures. Table 6-1 lists the paragraph titles and page numbers for the Troubleshooting section. If the AC Power Source does not appear to function normally, use this section to isolate the problem. If the problem cannot be found using these steps, consult the factory.

Table 6-1

PARAGRAPH	PROBLEM	PAGE
6.2	Poor Voltage Accuracy	96
6.3	Poor Output Voltage Regulation	96
6.4	Overtemperature Lamp On	97
6.5	Overload Lamp On	97
6.6	Can't Program AC Power Source via GPIB	98
6.7	Distorted Output	98
6.8	No Output	98

6.2 POOR VOLTAGE ACCURACY

If the power source exhibits poor programmed voltage accuracy, the following item may be at fault:

1. The calibration is incorrect.

   SOLUTION: Calibrate the output. Refer to Paragraph 4.3.1.

6.3 POOR OUTPUT VOLTAGE REGULATION

If the AC Power Source exhibits poor voltage regulation the following item may be at fault:

1. The Remote Sense lines are not connected at the same point monitored by the external voltmeter used for load regulation check.

SOLUTION: Connect AC voltmeter to Remote Sense lines.

6.4 OVERTEMPERATURE LAMP ON

If the power source OVERTEMP lamp is on, the following may be at fault:

1. Ambient temperature is too high.

   SOLUTION: Operate power source between 0 and 50°C.

2. Fan or ventilation holes are blocked.

   SOLUTION: Remove obstructions.

3. Fan not working.

   SOLUTION: Replace fan. Consult factory.

6.5 OVERLOAD LAMP ON

The OVERLOAD lamp comes on when the output load current has exceeded the programmed current limit value. If the AC Power Source OVERLOAD lamp is on, the following items may be at fault:

1. The output is overloaded.

   SOLUTION: Remove the overload.

2. The programmable current limit level is set too low for the load being driven.

   SOLUTION: Compute and reprogram the correct programmable current limit level.

3. The programmable current limit is incorrectly calibrated.

   SOLUTION: Perform the calibration in paragraph 4.4.4.

4. Incorrect AC Power Source configuration. Check the ELT screen. It should show more than 24 hours of operation. If it shows less than 24 hours consult the factory.

6.6 CAN'T PROGRAM AC POWER SYSTEM ON GPIB

If the power source does not respond to IEEE-488 GPIB programming, the following items may be at fault:

1. The power source unit address is incorrect.

   SOLUTION: Update address. See paragraph 3.6.1.

2. GPIB cable is loose at power source rear panel

   SOLUTION: Check connection, tighten jack screws.

3. The oscillator has failed.

   SOLUTION: Replace the oscillator. See Paragraph 6.10.

6.7 DISTORTED OUTPUT

The AC Power Source output may have a distorted sine wave from the following causes:

1. The power source output is overloaded.

   SOLUTION: Remove the overload or program the current limit to a higher value. Observe power source capabilities. See Section 1.

2. The crest factor of the load current exceeds 2.5. With this condition the distortion will be much higher at frequencies above 100 Hz.

   SOLUTION: Reduce the load or program the current limit to a higher value.

6.8 NO OUTPUT

If the AC Power Source has no output at the rear panel terminal block, TB1, the following items may be at fault:

1. If the Remote Sense lines are not connected correctly, there will be no output. The error message AMP FAULT will also be generated.

   SOLUTION Correctly connect the sense lines. Refer to Paragraph 2.6.

2. When the output is overloaded an error message will be generated and the output relays will open. The error message would be AMP FAULT.

   SOLUTION: Remove the overload. Observe the output power capabilities. Refer to Section 1.

3. There is no input to the power amplifiers from the oscillator. Check the oscillator signal at the system interface connector:

   J7-24 Oscillator Signal
   J7-7 Oscillator common/return

   Program 135.0 volts on the 135 volt range. The signal should be 5.74 ±0.5 VAC.

   SOLUTION: If there is no signal at the Systems Interface connector replace the oscillator. Refer to paragraph 6.10.
   SOLUTION: If the signal at the System Interface connector is greater than 5.74 VAC, it may be necessary to replace the respective amplifier. Refer to paragraph 6.11.

4. The internal amplifier fuse, F2, has failed.

   SOLUTION: Replace the fuse.

6.9 MODULE REMOVAL

Figure 6-1 shows the location of the internal modules and assemblies. The figure shows the Amplifier Module, A7, with the insulator removed.

6.10 OSCILLATOR MODULE REMOVAL/REPLACEMENT

If a fault is found that requires the replacement of the Oscillator Module (assembly A8) follow the following steps and refer to Figure 6-1 for the module locations:

1. Turn off the front panel circuit breaker.

2. Remove the Keyboard/Display assembly (Oscillator Module front panel) by loosening the two captive screws on its front panel.

3. Unplug the Oscillator Module, A8, by sliding out the package of PC assemblies with the front panel display.

4. The module is now removed. To replace the module follow these steps in reverse order.

6.11 AMPLIFIER REMOVAL/REPLACEMENT

If a fault has been found that indicates the failure of the amplifier module (assembly A7), check the condition of the +300 VDC fuse before replacing the amplifier. Refer to Figure 6-1 for the location of the fuse.

If it is determined that the amplifier module must be replaced perform the following procedure:

1. Turn off the input circuit breaker.

2. Disconnect AC input power at TB1.

3. Remove the AC Power Source top cover.

4. Remove the four screws that hold the amplifier module from the far end opposite the connector.

5. Remove the amplifier by lifting its end up and disconnecting from the connector.

6. The amplifier may be replaced by following this procedure in reverse order.

7. Check the amplifier 15 amp fuse (F2) located on the DC Supply Board, A6, and replace it if necessary.

8. After an amplifier has been replaced, readjust its gain. Refer to Section 4.

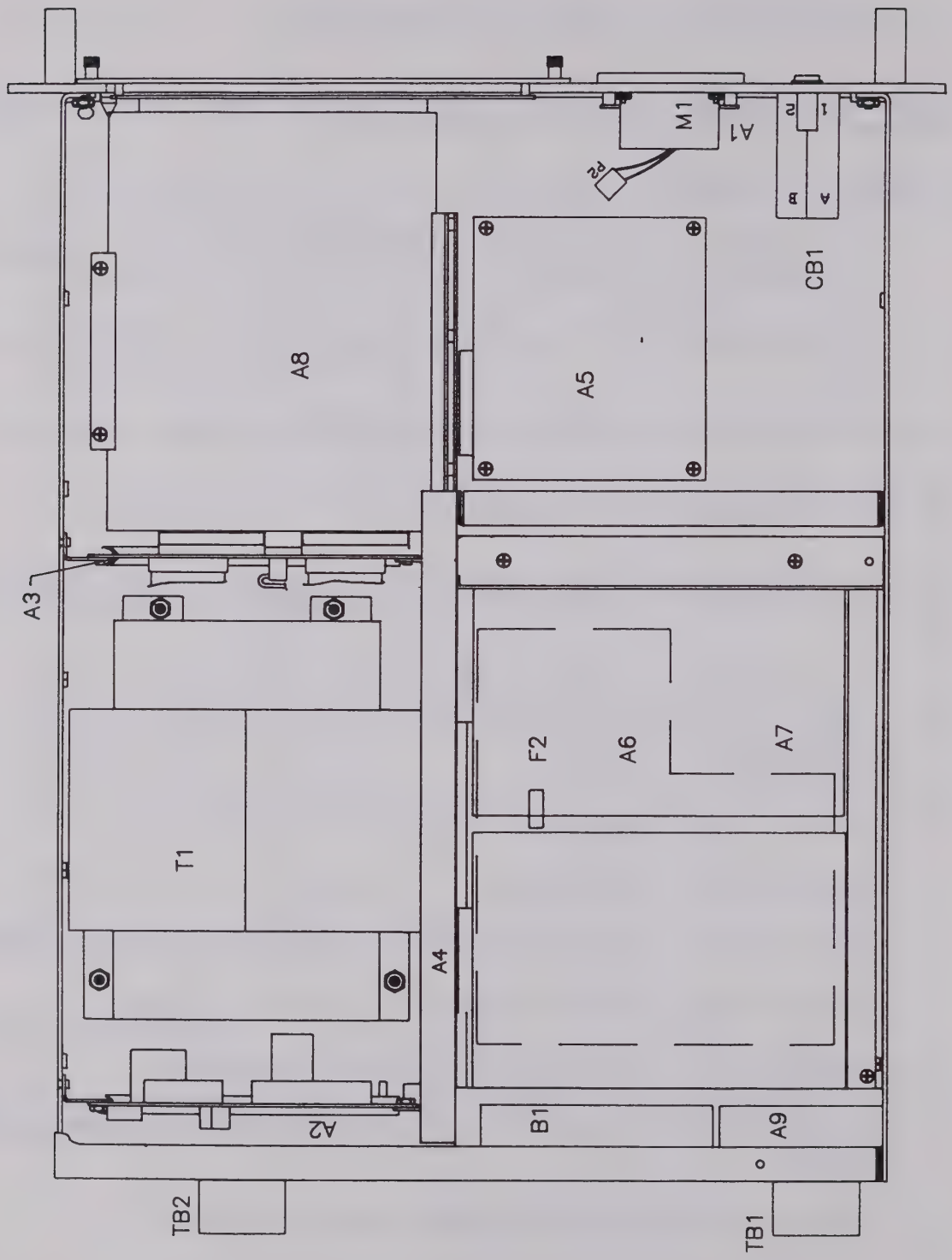


FIGURE 6-1
MODULE LOCATION

7 REPLACEABLE PARTS

7.1 GENERAL

This section contains ordering information and a list of replaceable parts. The list includes the parts description and California Instruments part numbers.

7.2 ORDERING INFORMATION

In order to ensure prompt, accurate service, please provide the following information, when applicable for each replacement part ordered.

a. Model number and serial number of the instrument.

b. California Instruments part number for the subassembly where the component is located. (PARENT ITEM NO.)

c. Component reference designator. (SEQ NO.)

d. Component description.

e. Component manufacturers' FSCM number. (VENDOR)

f. California Instruments' part number (COMPONENT ITEM NO.)

All replaceable part orders should be addressed to:

California Instruments
Attention: Customer Service
9025 Balboa Avenue
San Diego, California 92123-1509

TOP ASSEMBLY REPLACEABLE PARTS FOR 2001L TOP ASSEMBLY NO: 4005-411-1

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	VENDOR	QTY
A1	4005-700-1	PC ASSY, INDICATOR,LIMIT	16067	1.0
A2	4005-705-1	PC ASSY, RANGE/RELAY	16067	1.0
A3	4005-702-1	PC ASSY, OSCILLATOR INTERFACE	16067	1.0
A4	4005-708-1	PC ASSY, MOTHER	16067	1.0
A5	4005-709-1	PC ASSY, CURRENT LIMIT	16067	1.0
A6	4008-712-1	PC ASSY, DC SUPPLY	16067	1.0
A7	4009-423-8	PC ASSY, HEATSINK, SW AMP	16067	1.0
A8	4005-404-5	PC ASSY, MODULE OSC.	16067	1.0
A9	4005-710-1	PC ASSY, EMI FILTER	16067	1.0
B1	241180	FAN, 4", 48 VDC	23936	1.0
F2	270167	FUSE,15A,250V	71400	1.0

TOP ASSEMBLY REPLACEABLE PARTS FOR 1501L TOP ASSEMBLY NO: 4005-403-1

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	VENDOR	QTY
A1	4005-700-1	PC ASSY, INDICATOR	16067	1.0
A2	4005-705-1	PC ASSY, RANGE/RELAY	16067	1.0
A3	4005-702-1	PC ASSY, OSCILLATOR INTERFACE	16067	1.0
A4	4005-703-1	PC ASSY, MOTHER	16067	1.0
A5	4005-704-1	PC ASSY, CURRENT LIMIT	16067	1.0
A6	4008-712-1	PC ASSY, DC SUPPLY	16067	1.0
A7	4009-423-2	PC ASSY, HEATSINK, SW AMP	16067	1.0
A8	4005-404-3	PC ASSY, MODULE OSC.	16067	1.0
A9	4005-710-1	PC ASSY, EMI FILTER	16067	1.0
B1	241180	FAN, 4", 48 VDC	23936	1.0
F2	270167	FUSE,15A,250V	71400	1.0

TOP ASSEMBLY REPLACEABLE PARTS
FOR 751L
TOP ASSEMBLY NO: 4005-405-1

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	VENDOR	QTY
A1	4005-700-1	PC ASSY, INDICATOR	16067	1.0
A2	4005-705-2	PC ASSY, RANGE/RELAY	16067	1.0
A3	4005-702-1	PC ASSY, OSCILLATOR INTERFACE	16067	1.0
A4	4005-703-1	PC ASSY, MOTHER	16067	1.0
A5	4005-706-2	PC ASSY, CURRENT LIMIT	16067	1.0
A6	4008-712-2	PC ASSY, DC SUPPLY	16067	1.0
A7	4009-423-2	PC ASSY, HEATSINK, SW AMP	16067	1.0
A8	4005-404-3	PC ASSY, MODULE OSC.	16067	1.0
A9	4005-710-1	PC ASSY, EMI FILTER	16067	1.0
B1	241180	FAN, 4", 48 VDC	23936	1.0
F2	270167	FUSE,15A,250V	71400	1.0

8 MIL-STD-704D

8.1 GENERAL

The MIL-704D option is capable of performing all sections of MIL-STD-704D. It will perform all tests in the order listed below or part of the test. There is a 5 second delay between tests to allow the operator to evaluate the result of the test.

8.2 INITIAL SETUP

Nominal parameters for the AC Power Source shall be as follows:

OUTPUT VOLTAGE: 115 L-N

OUTPUT FREQUENCY: 400

8.3 TEST PERFORMED

NOTE: All figures applied for single phase only.

8.3.1 Steady state test. (Refer to MIL-704D Doc. Table 1)

1. Voltage per Figure 1, page 122.
2. Voltage unbalance per Figure 2, page 122.
   (Does not apply to 751L or 1501L.)
3. Voltage phase difference per Figure 3, page 122.
   (Does not apply to 751L or 1501L.)
4. Waveform distortion factor per Figure 4, page 122.
5. Frequency per Figure 5, page 122.

8.3.2 Transient

1. Voltage Transient (Refer to MIL-704D Doc. Figure 5.)
   High voltage Transient per Figure 6, page 123.
   Low voltage Transient per Figure 7, page 123.

2. Frequency Transient (Refer to MIL-704D Doc. Figure 6)
   High frequency Transient per Figure 8, page 124.
   Low frequency Transient per Figure 9, page 124.

8.3.3 Abnormal operation

1. Abnormal voltage (Refer to MIL-704D Doc. Figure 7).
   Overvoltage per Figure 10, page 125.
   Undervoltage per Figure 11, page 125.

2. Abnormal frequency (Refer to MIL-704D Doc. Figure 8)
   Overfrequency per Figure 12, page 126.
   Underfrequency per Figure 13, page 126.

8.3.4 Emergency operation (Refer to MIL-704D Doc. 5.2.5)

1. Voltage per Figure 14, page 127.
2. Frequency per Figure 15, page 127.

8.4 KEYPAD ENTRY (Refer to page 120 for Keyboard flow chart)

To perform a test from the key board, the following key sequence is required:

704 ENT

The following screen will appear:

MIL704D:SelA
ENT=all CLR=EXIT

Pressing the A, B, C or any combination selects the phase in test. Press ENT without the phase select for simultaneous three-phase test.

The following screen appears for a short time.

TEST A
CLR to Reselect

The next screen is:

Apply Nom Output
Press ENT

When ENT is selected the following screen appears:

Press MNU to
Select Test

The MNU screen has two lines of selection shown at a time.

There are 3 different types of operations that can be selected from a MENU screen. If the word MENU appears for the item selected, another MENU screen will be displayed. If the word TEST appears for the item selected, the test will start. The display will return to the previous screen if the word RETURN appears for the item selected.

The Main Menu will appear as follows:

1=Steady St Menu
2=Transient Menu
3=Abnormal Menu
4=Emergency Menu
5=MIL704D Test
6=Return

If key 1 is selected "Steady State: from the Main Menu, the following Menu will appear:

1=Voltage Test
2=Unbalance Test (This test is not applicable to 751L or 1501L.)
3=Phase dif Test (This test is not applicable to 751L or 1501L.)
4=Wave dist Test
5=Frequency Test
6=Steady St Test
7=Return

If key 2 is selected "Transient" from the Main Menu, the following Menu will appear:

1=Volt Trns Menu
2=Freq Trns Menu
3=Transient Test
4=Return

If key 1 is selected from the Transient Menu the following Menu will appear:

1=High Volt Test
2=Low Volt Test
3=Volt Trns Test
4=Return

If key 2 is selected from the Transient Menu the following Menu will appear:

1=High Freq Test
2=Low Freq Test
3=Freq Trns Test
4=Return

If key 3 is selected "Abnormal" from the Main Menu, the following Menu will appear:

1=Abnl Volt Menu
2=Abnl Freq Menu
3=Abnormal Test
4=Return to Main Menu

If key 1 is selected from the "Abnormal" Menu, the following Menu will appear:

1=Overvolt Test
2=Undervolt Test
3=Abnl Volt Test
4=Return

If key 2 is selected from the "Abnormal" menu, the following Menu will appear:

1=Overfreq Test
2=Underfreq Test
3=Abnl Freq Test
4=Return

If key 4 is selected "Emergency" from the Main Menu, the following Menu will appear:

1=Emrg Volt Test
2=Emrg Freq Test
3=Emergency Test
4=Return

8.5 GPIB OPERATION (Refer to page 101 for syntax diagram)

The following command will be used to execute the appropriate part of all of the test.

MIL704D Test all MIL704D Sections
MIL704D :STEady state
MIL704D :STEady state :VOLTage
MIL704D :STEady state :WAVeform :DISTortion
MIL704D :STEady state :FREQuency

MIL704D :TRANsient
MIL704D :TRANsient :VOLTage
MIL704D :TRANsient :VOLTage :HIGH
MIL704D :TRANsient :VOLTage :LOW
MIL704D :TRANsient :FREQuency
MIL704D :TRANsient :FREQuency:HIGH
MIL704D :TRANsient :FREQuency:LOW

MIL704D :ABNormal
MIL704D :ABNormal :VOLTage
MIL704D :ABNormal :VOLTage :OVER
MIL704D :ABNormal :VOLTage :UNDer
MIL704D :ABNormal :FREQuency
MIL704D :ABNormal :FREQuency :OVER
MIL704D :ABNormal :FREQuency :UNDer

MIL704D :EMERgency
MIL704D :EMERgency :VOLTage
MIL704D :EMERgency :FREQuency

All lower case letters are option.

8.6 TEST SPECIFICATION

8.6.1 STEADY STATE

1. Steady state voltage test (Figure 1).

   MIL704D :STEady state :VOLTage

   This test will change the output voltage simultaneously from 115 volts to 108 volts for 5 seconds to 118 volts for 5 seconds.

2. Steady state voltage unbalance test (Figure 2).

   MIL704D :STEady state :VOLTage :UNBalance

   This test has no meaning for 751L or 1501L and should not be executed.

3. Steady state voltage phase difference test (Figure 3).

   MIL704D :STEady state :PHASe :DIFFerence

   This test has no meaning for 751L or 1501L and should not be executed.

4. Steady state waveform distortion (Figure 4).

   MIL704D :STEady state :WAVeform :DISTortion

   This test will generate a 5% distortion on the selected phase for 5 seconds.

5. Steady state frequency test (Figure 5).

   MIL704D :STEady state :FREQuency

   This test will change the programmed frequency from 400 Hz to 393 Hz for 5 seconds then to 407 Hz for 5 seconds.

6. Steady state test

   MIL704D :STEady state

   This test will perform all the above five tests in the same order above. A 5 second pause between tests is asserted.

8.6.2. TRANSIENT

1. Transient high voltage test (Figure 6).

   MIL704D :TRANsient :VOLTage :HIGH

   This test requires a 180 volts range. A range change will take place if the power source is not set for the high range. The output voltage will drop temporarily to allow for range change and after 5 seconds the test will begin.

   The output will go to 180 volts for 10 msec and will drop gradually to 115 volts in 81.25 msec. After 5 seconds, a range change will take place to the original setup.

2. Transient low voltage test (Figure 7).

   MIL704D :TRANsient :VOLTage :LOW

   The output voltage will drop to 80 volts for 10 msec. It will gradually rise to 115 volts in 81.25 msec.

3. Transient voltage test

   MIL704D :TRANsient :VOLTage

   This test will combine High voltage transient and Low voltage transient. There will be a pause of 5 seconds between tests. If the voltage range is below 180 volts, the High voltage transient test will not take place.

4. Transient high frequency test (Figure 8).

   MIL704D :TRANsient :FREQuency:HIGH

   This test will step up the frequency from 400 Hz to 425 Hz. The frequency will step down to 400 Hz in the following sequence:

   425 Hz for 1 second
   420 Hz for 4 seconds
   410 Hz for 5 seconds
   407 Hz for 4 seconds

5. Transient low frequency test (Figure 9).

   MIL704D :TRANsient :FREQuency:LOW

This test will step down the frequency from 400 Hz to 375 Hz. The frequency will step up to 400 Hz in the following sequence:

375 Hz for 1 second
380 Hz for 4 seconds
390 Hz for 5 seconds
393 Hz for 4 seconds

6. Transient frequency test

MIL704D :TRANsient :FREQuency

This test will combine the high frequency transient and the low frequency transient. There is a pause of 5 seconds between tests.

8.6.3. ABNORMAL

1. Abnormal overvoltage test (Figure 10).

MIL704D :ABNormal :VOLTage :OVER

This test requires a 180 volt range. A range change will take place if the power source is not set for the high range. The output voltage will drop temporarily to allow for the range change and after 5 seconds the test will begin.

The output will go to 180 volts for 50 msec and will drop gradually to 125 volts in 450 msec. The output voltage will remain at 125 volts for 9.5 seconds before it drops to 115 volts. After 5 seconds, a range change will take place to the original setup.

2. Abnormal undervoltage test (Figure 11).

MIL704D :ABNormal :VOLTage :UNDer

The output voltage will drop to 0 volts for 7 seconds. It step up to 100 volts for 3 seconds before it will go to 115 volts.

3. Abnormal voltage test

MIL704D :ABNormal :VOLTage

This test will combine Abnormal overvoltage and Abnormal undervoltage. There will be a pause of 5 seconds between tests. If the voltage range is below 180 volts the Abnormal overvoltage test will not take place.

4. Abnormal overfrequency test (Figure 12)
MIL704D :ABNormal :FREQuency :OVER

This test will step up the frequency from 400 Hz to 480 Hz. The frequency will step down to 400 Hz in the following sequence:

480 Hz for 5 seconds
425 Hz for 5 seconds

5. Abnormal underfrequency test (Figure 13)

MIL704D :ABNormal :FREQuency :UNDer

This test will step down the frequency from 400 Hz to 0 Hz. The frequency will step up to 400 Hz in the following sequence:

0 Hz for 5 seconds
375 Hz for 5 seconds

6. Abnormal frequency test

MIL704D :ABNormal :FREQuency

This test will combine the Abnormal overfrequency and the Abnormal underfrequency . There is a pause for 5 seconds between tests.

8.6.4. EMERGENCY

1. Emergency voltage test (Figure 14).

MIL704D :EMERgency :VOLTage

This test will step down the voltage to 104 volts for 5 seconds. Also it will step up the voltage to 122 volts for another 5 seconds.

2. Emergency frequency test (Figure 15).

MIL704D :EMERgency :FREQuency

This test will step down the frequency to 360 Hz for 5 seconds then will step up the frequency to 440 Hz for 5 seconds.

3. Emergency test

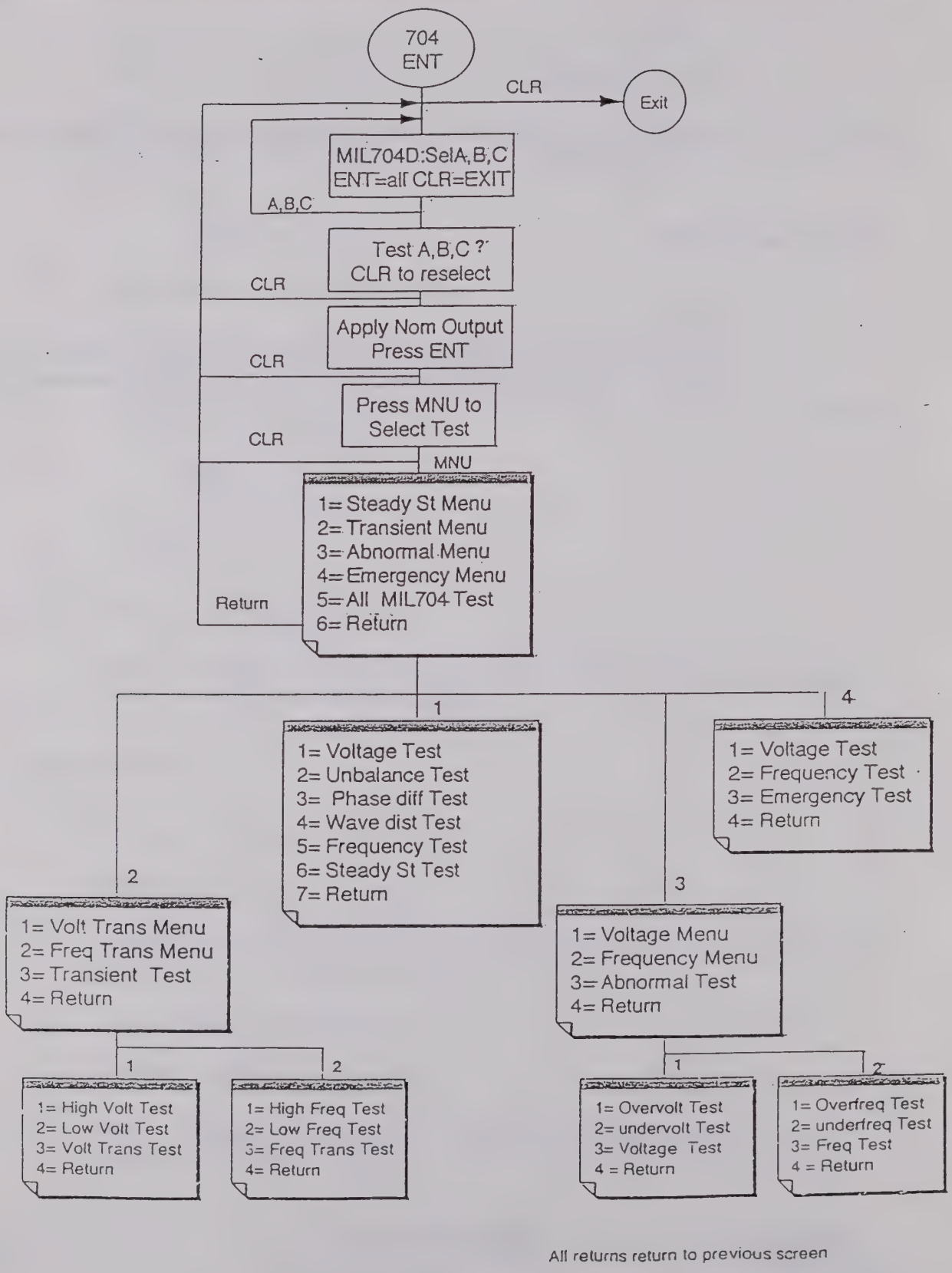
MIL704D :EMERgency

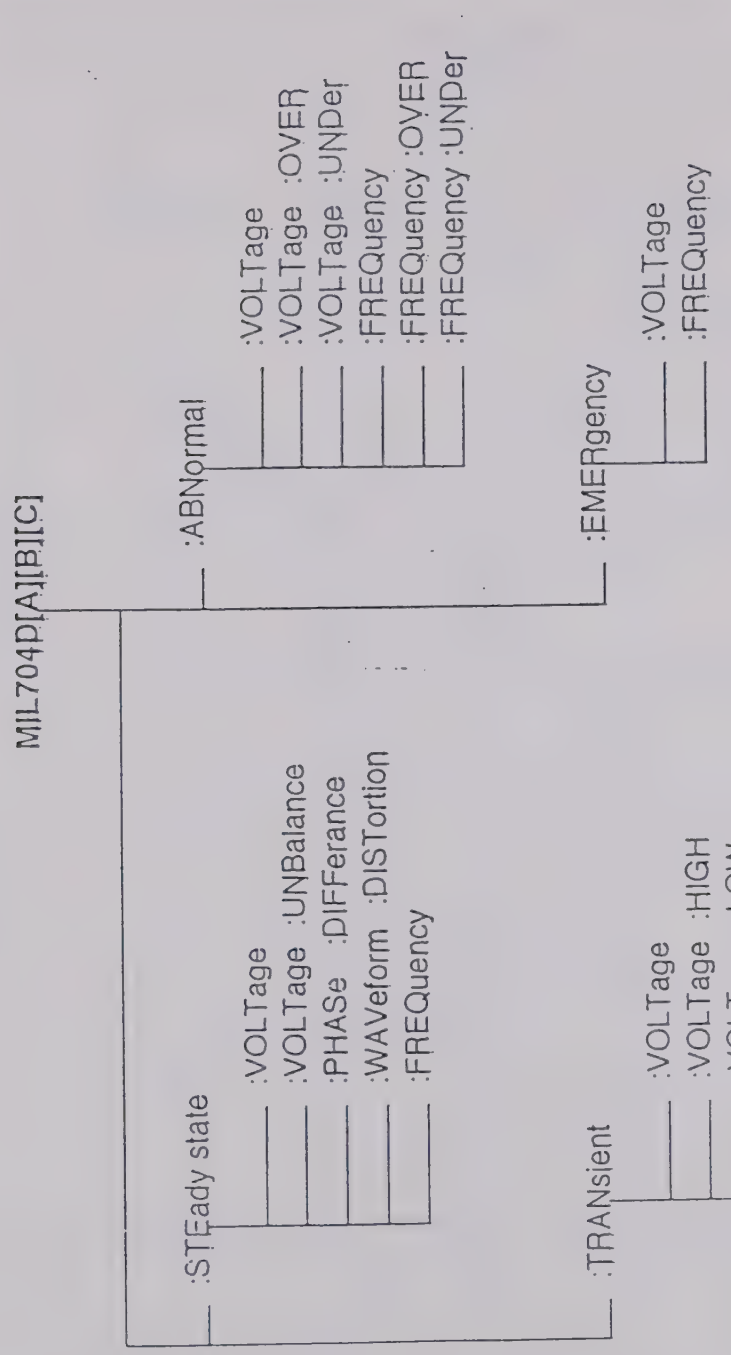
This test will combine the voltage emergency test and the frequency emergency test. A pause of 5 seconds between tests is asserted.

8.6.5 MIL704D TEST

MIL704D

This test will combine all the tests listed above in one test in the sequence listed. A 5 second time delay separate the parts of the test. Tests will be performed on the selected phases only.

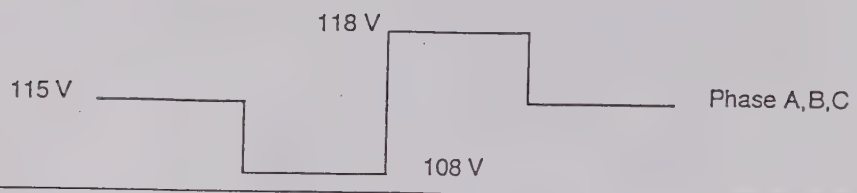

704
ENT
CLR
Exit
MIL704D:SelA,B,C
ENT=all CLR=EXIT
A,B,C
Test A,B,C ?
CLR to reselect
CLR
Apply Nom Output
Press ENT
CLR
Press MNU to
Select Test
CLR
MNU
1= Steady St Menu
2= Transient Menu
3= Abnormal Menu
4= Emergency Menu
5= All MIL704 Test
6= Return
Return
1
1= Voltage Test
2= Unbalance Test
3= Phase diff Test
4= Wave dist Test
5= Frequency Test
6= Steady St Test
7= Return
4
1= Voltage Test
2= Frequency Test
3= Emergency Test
4= Return
2
1= Volt Trans Menu
2= Freq Trans Menu
3= Transient Test
4= Return
3
1= Voltage Menu
2= Frequency Menu
3= Abnormal Test
4= Return
1
1= High Volt Test
2= Low Volt Test
3= Volt Trans Test
4= Return
2
1= High Freq Test
2= Low Freq Test
3= Freq Trans Test
4= Return
1
1= Overvolt Test
2= undervolt Test
3= Voltage Test
4 = Return
2
1= Overfreq Test
2= underfreq Test
3= Freq Test
4 = Return
All returns return to previous screen



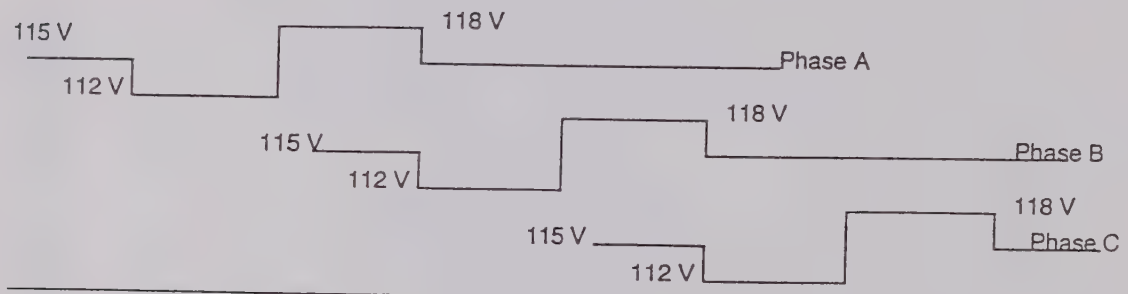
MIL704D SYNTAX FLOW

Steady state

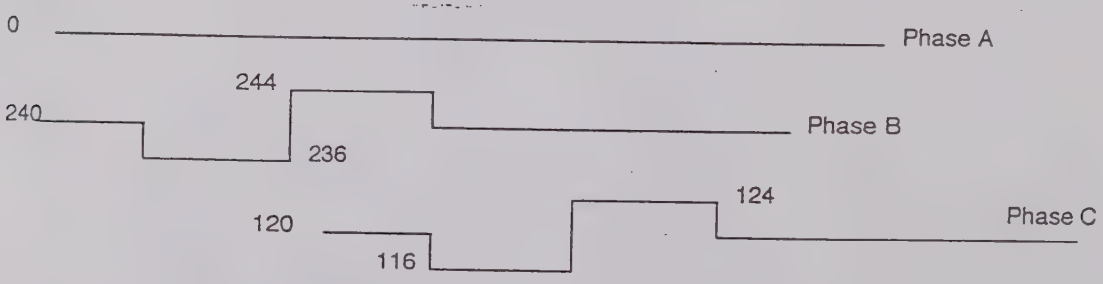
Voltage figure 1



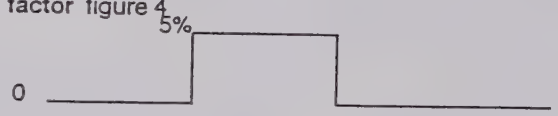
Voltage Unbalance figure 2



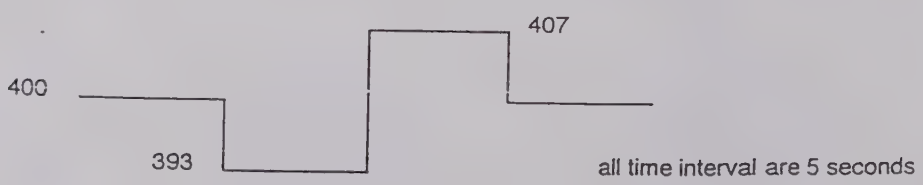
Voltage Phase difference figure 3



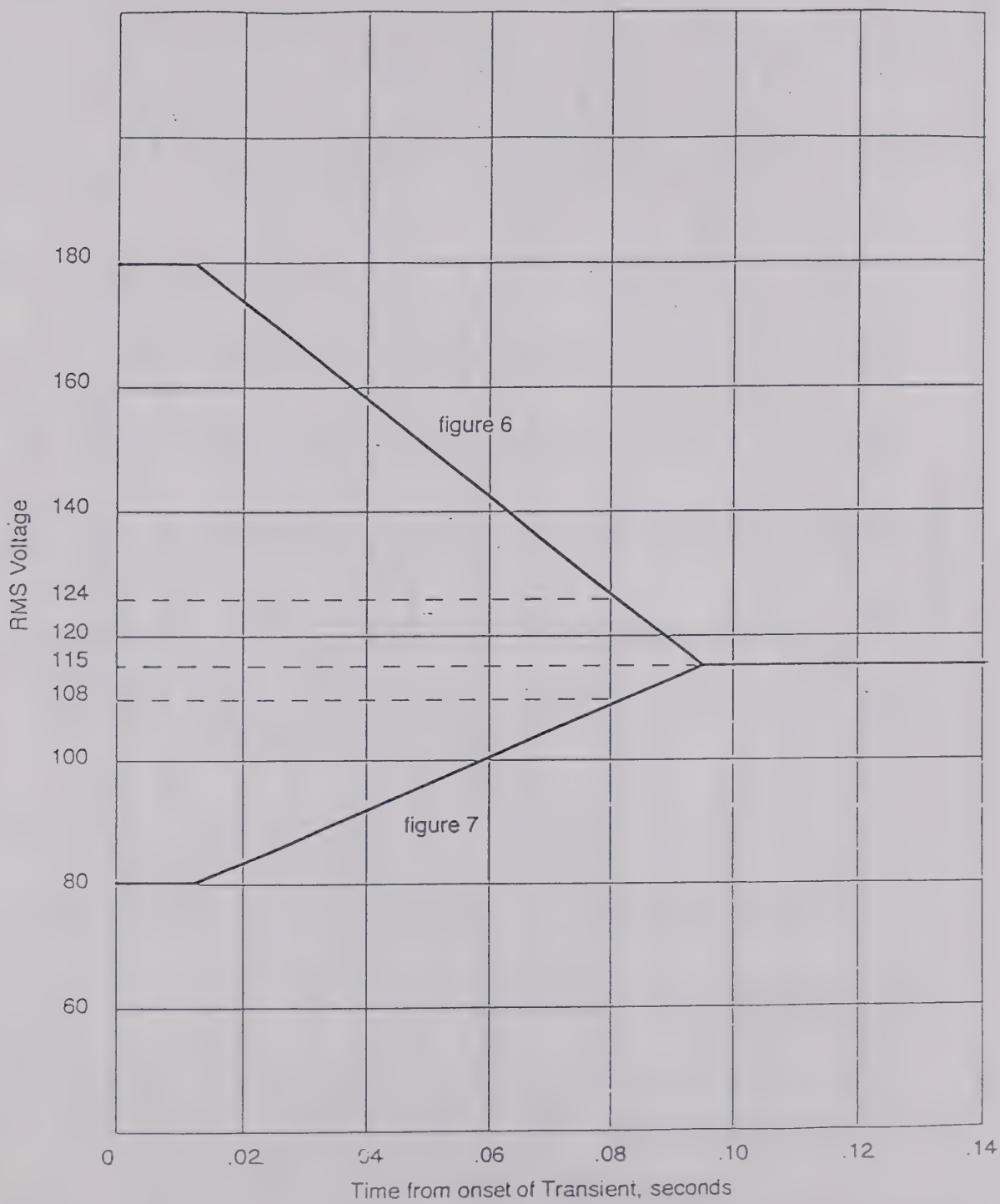
Distortion factor figure 4



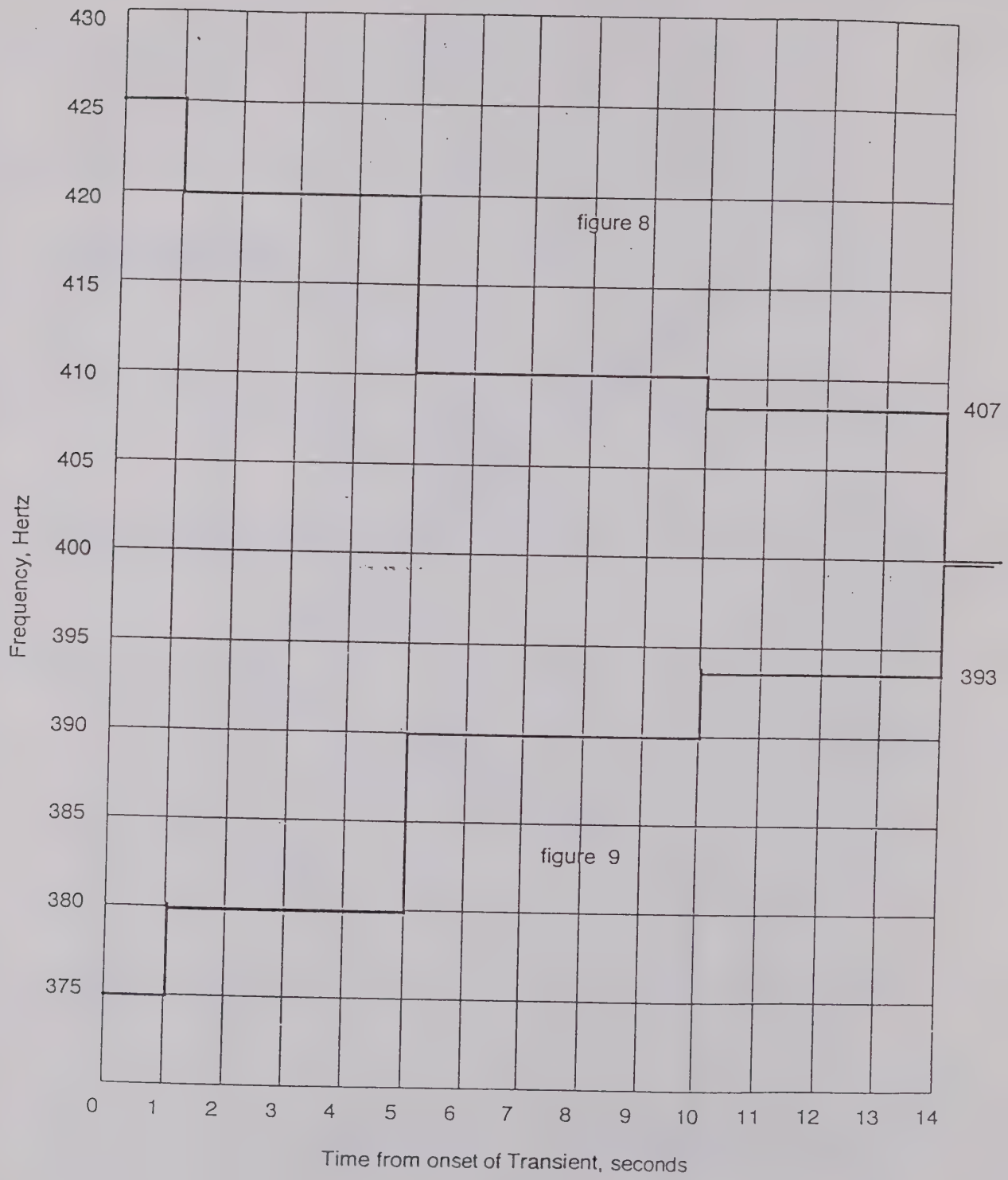
Frequency figure 5



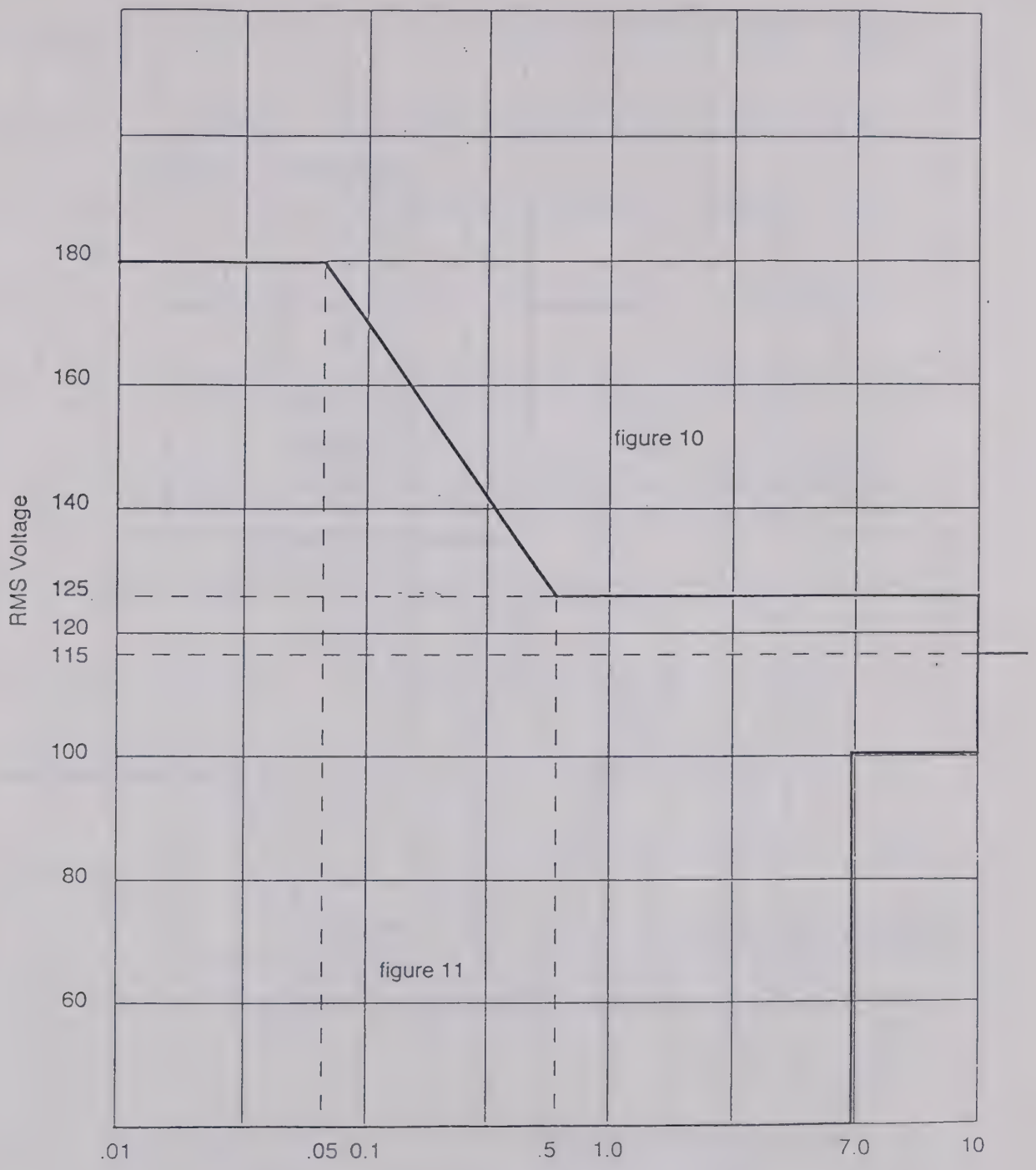
all time interval are 5 seconds



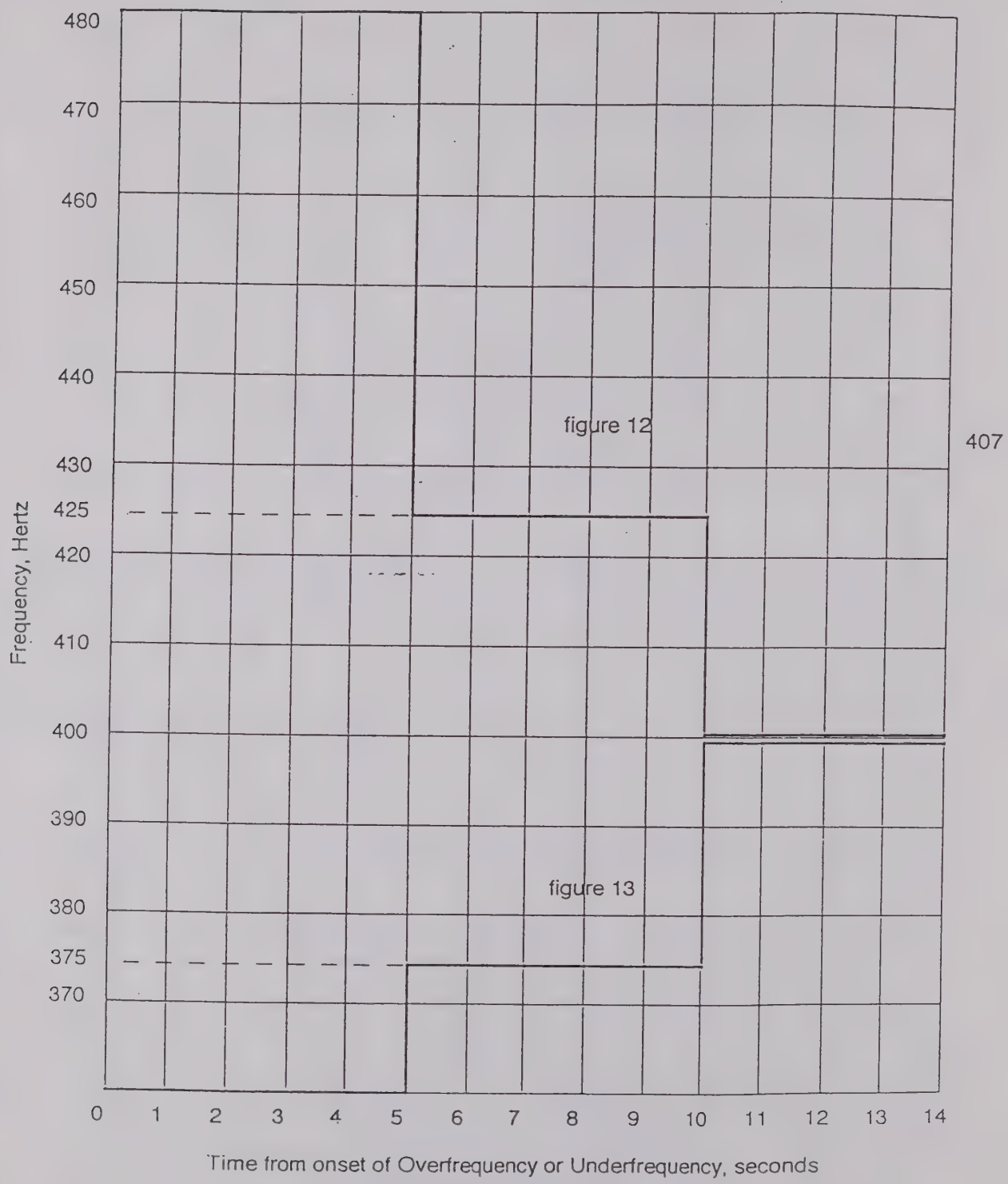
Voltage transient
figure 6,7



Frequency Transient
figure 8,9

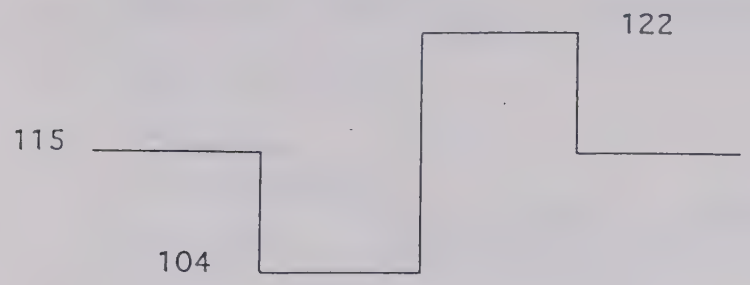


Abnormal operation
figure 10,11

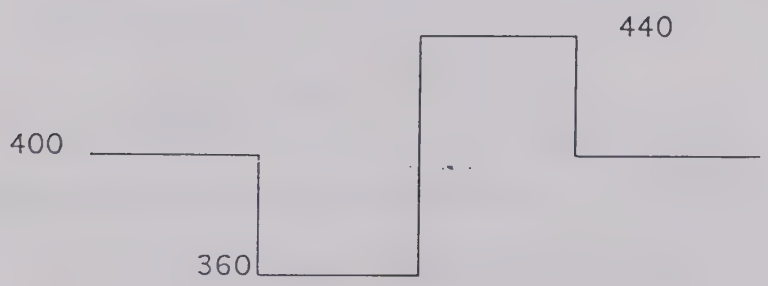


Abnormal Frequency
figure 12,13

Emergency Voltage figure 14



Emergency Frequency figure 15



all time interval are 5 seconds

9 RTCA/DO-160C

9.1 GENERAL

The RTCA/DO-160C option is capable of performing all sections of RTCA/DO-160C for the AC Source signal.

9.2 INITIAL SETUP

Nominal parameters for the AC Power source shall be as follows:

Output Voltage	115V L-N
Output Frequency	400 Hz

9.3 TEST PERFORMED

9.3.1 NORMAL STATE

1. Normal State Voltage and Frequency test
2. Waveform Distortion test
3. Voltage Modulation test
4. Frequency Modulation test
5. Momentary Power Interrupt (Undervoltage) test
6. Voltage Surge (Overvoltage) test

9.3.2 EMERGENCY TEST

1. Emergency Voltage and Frequency test

9.3.3 ABNORMAL TEST

1. Abnormal Voltage and Frequency test
2. Momentary Undervoltage test
3. Voltage Surge test

9.4 KEYPAD ENTRY (Refer to Figure 1 for Keyboard Flow Chart)

To perform a test from the keyboard, the following key sequence is required:

160 ENT

The following screen will appear:

DO160C: SelA
ENT=all CLR=EXIT

Press the ent key. No phase selection is required.

The following screen appears for a short time:

Test A
CLR to Reselect

The next screen is:

Apply Nom output
Press ENT

When ENT is selected the following screen appears;

Press MNU to
Select Test

The MNU screen has two lines of selection shown at a time.

There are three different types of operations that can be selected from the MENU screen. If the word MENU appears for the items selected, another MENU screen will be displayed. If the word Test appears for the item selected, the test will start. The display will return to the previous screen if the word RETURN appears for the item selected.

The Main Menu will appears as follows:

1 = Normal Menu
2 = Emergency Menu
3 = Abnormal Menu
4 = Return

If Key 1 is selected "Normal Menu" from the Main Menu, the following Menu will appear:

1 = Volt/Freq Menu
2 = Unbalance Test (three-phase only)
3 = Volt Mod Test
4 = Power Int Test
5 = Volt Surge Test
6 = Wave Dist Test
7 = Freq Mod Test
8 = Return

If Key 2 is selected "Emergency Menu" from the Main Menu, the following Menu will appear:

1 = Emg V/F Menu
2 = Emg Unbal Test (three-phase only)
3 = Return

If Key 3 is selected "Abnormal Menu" from the Main Menu, the following Menu will appear:

1 = Ab Volt Menu
2 = Ab Vunder Test
3 = Ab Vsurge Test
4 = Return

If Key 1 is selected "Volt/Freq Menu" from the Normal Menu, the following Menu will appear:

1 = Under Volt Test
2 = Over Volt Test
3 = Return

If Key 1 is selected "Volt/Freq Menu" from the Emergency Menu, the following Menu will appear:

1 = Emg Vunder Test
2 = Emg Vover Test
3 = Return

If Key 1 is selected "Volt Menu" from the Abnormal Menu, the following Menu will appear:

1 = Ab Vunder Test
2 = Ab Vover Test
3 = Return

If Key 3 or Key 7 is selected from the "Normal Menu", another screen will appear as follows:

Enter Modulation
Rate in Hz and ENT.
The numeric value must be within the limits for the test performed. See Figure 2 and Figure 3.

If Key 4 is selected from the "Normal Menu", the following screen will appear as follows:

Enter Test
Number 1 to 15 and ENT (see Table 1)

9.5 GPIB OPERATION

The following command will be used to execute the appropriate section of DO-160C.

Remote Command
Items contained within square brackets [ ] are optional

DO160 :NORMal state :VOLT_FREQ :MINinum
DO160 :NORMal state :VOLT_FREQ :MAXimum
D0160 :NORMal state :WAVe form :DISTortion
DO160 :NORMal state :VOLTage :MODulation <numeric>
DO160 :NORMal state :FREQency :MODulation <numeric>
DO160 :NORMal state :VOLTage :UNDer<numeric>
DO160 :NORMAL state :VOLTage :OVER

DO160 :EMERgency :VOLT_FREQ :MINimum
DO160 :EMERgency :VOLT_FREQ :MAXimum
DO160 :EMERgency :VOLTage :UNBalance

DO160 :ABNormal stage :VOLTage :MINimum
DO160 :ABNormal state :VOLTage :MAXimum
DO160 :ABNormal stage :VOLTage :UNDer
DO160 :ABNormal state :VOLTage :OVER

9.6 TEST SPECIFICATION

9.6.1 NORMAL STATE

9.6.1.1 Normal State Minimum Voltage and Frequency Test

DO160 :NORMal state :VOLT_FREQ :MINimum

This test will change the output voltage for single phase from 115V to 104V and for three-phase from 115V to 105.5V and the frequency from 400 Hz to 380 Hz. The test will last for 30 minutes. The CLR Key in local operation will terminate the test at any time. Group execute trigger will terminate the test remotely. The unselected phases will remain at 115 volts.

9.6.1.2 Normal State Maximum Voltage and Frequency Test

DO160 :NORMal state :VOLT_FREQ :MAXimum

This test will change the output voltage for single phase from 115V to 122 volts and from 115V to 120.5 volts for three-phase and the frequency from 400 Hz to 420 Hz. The test will last for 30 minutes. The CLR Key in local operation will terminate the test at any time. Group execute trigger will terminate the test remotely. The unselected phase will remain at 115 volts.

9.6.1.3 Normal State Waveform Distortion

D0160 :NORMal state :WAVe form :DISTortion

This test will generate a 5% distortion on the selected phase. The test will last for 30 minutes. This test can be terminated at any time.

9.6.1.4 Normal State Voltage Modulation

DO160 :NORMal state :VOLTage :MODulation <numeric>

This test requires a numeric value equal to the modulation rate in Hz. See Figure 2. The amplitude modulation is calculated based on the modulation rate. This test will last for 2 minutes.

9.6.1.5 Normal State Frequency Modulation

DO160 :NORMal state :FREQency :MODulation <numeric>

This test requires a numeric value equal to the modulation rate in Hz. See Figure 3. The frequency modulation is calculated based on the modulation rate. This test will last for two minutes.

The output voltage will rise to 180 volts for 100 msec and will drop to 148 volts for s1 sec before it returns to 115. volts.

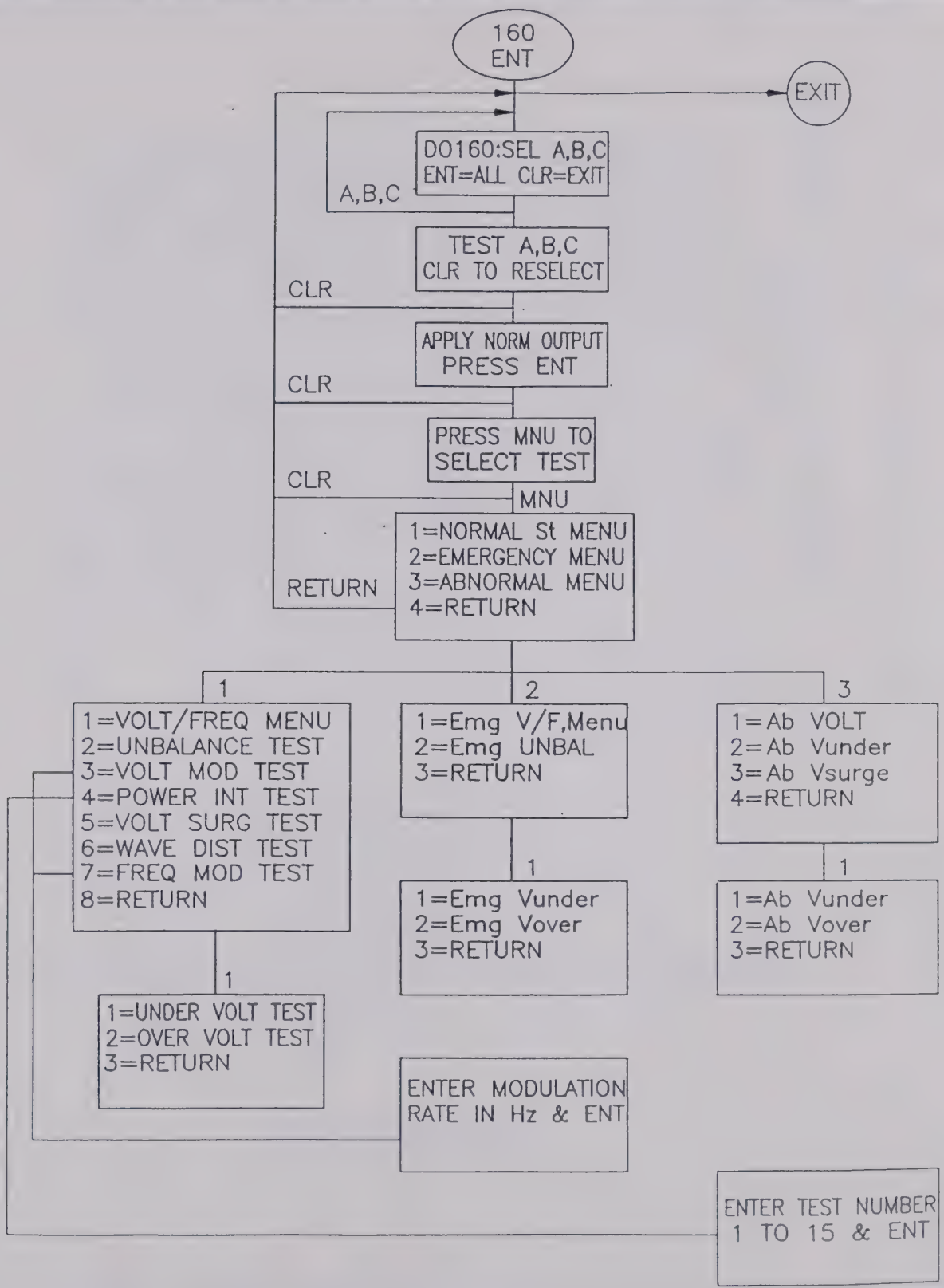
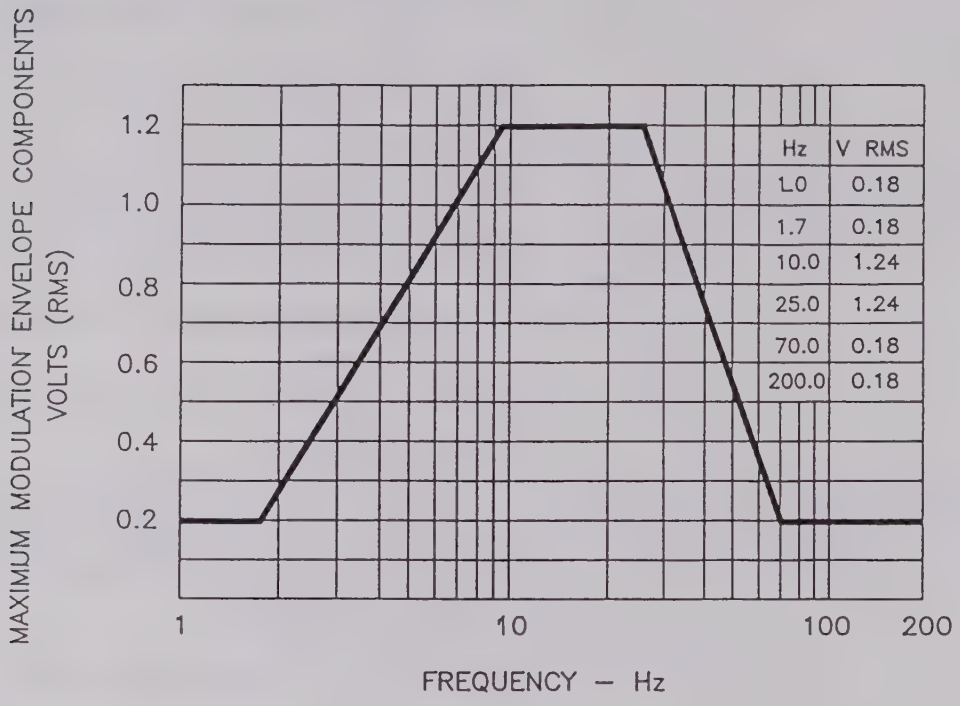


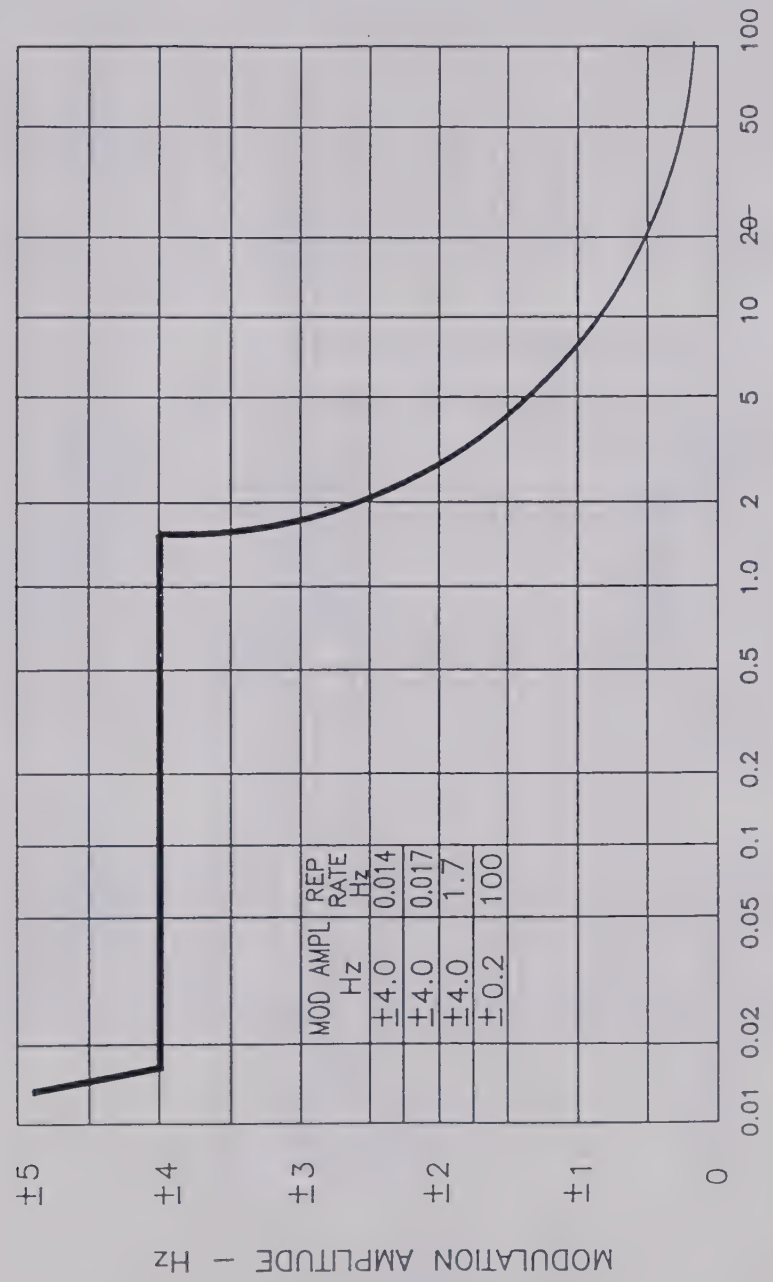
FIGURE 1

All returns return to previous screen



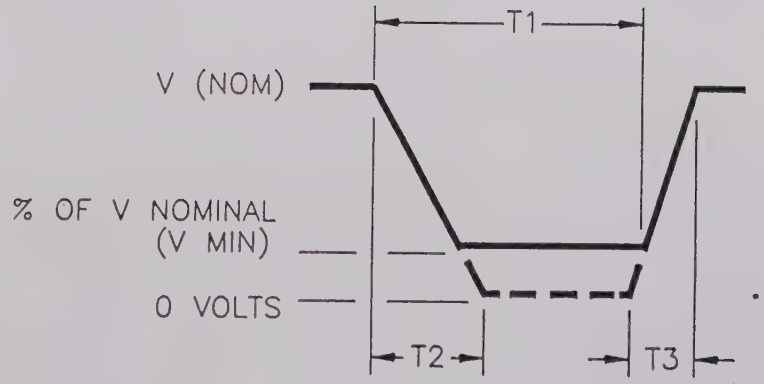
FREQUENCY CHARACTERISTICS OF AC VOLTAGE MODULATION ENVELOPE

FIGURE 2



CHARACTERISITICS OF AC FREQUENCY MODULATION

FIGURE 3



NOTES: 1. Definitions

T1 – Power interrupt time.
T2 – Time it would take for the applied voltage to decay from V (nom) to zero volts>
T3 – Time it would take for the applied voltage to rise from zero to V (nom) volts.
V MIN – The minimum level (expressed as a percentage of V NOMINAL) to which the applied voltage is permitted to decay.

2. Tolerance to T1, T2 and V MIN = ±10%

TEST CONDITION NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
T1 (MILLISECONDS)	2	10	25	50	75	100	200	1000	10	25	50	75	100	200	1000
T2 (MILLISECONDS)	<1	20*	20	20	20	20	20	20	50*	50*	50	50	50	50	50
T3 (MILLISECONDS)	<1	5	5	5	5	5	5	5	20	20	20	20	20	20	20
% OF V NOMINAL (V MIN)	0	50	15	10	5	0	0	0	20	50	0	15	5	0	0

* VOLTAGE WILL NOT REACH ZERO IN THIS TEST CONDITION.

TABLE 1

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS CORPORATION warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, including the model number and serial number. On receipt of this information, service information or a Return Material Authorization (RMA) number will be given. Add RMA number to shipping label. .Pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No. or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, San Diego, CA. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested when it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

MP MASTER
MA28320